D101.22:750-22

DA PAMPHLET 750-22

TROUBLESHOOTING EQUIPMENT

IN COMBAT UNITS

DA Pam 750-22
Headquarters, Department of the Army
Washington, D.C. 15 November 1973

INTRODUCTION

The purpose of this pamphlet is to support the U. S. Army Command Maintenance Program (COMAINT). It is designed to provide supervisors and other users with a consolidated, simplified reference on use of troubleshooting equipment authorized at the organizational maintenance level.

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This pamphlet may be used in conjunction with a series of Army posters on how to use troubleshooting equipment. The posters are:

DA POSTER 750-53	Multimeter TS-352B/U
DA POSTER 750-59	Compression Gage
DA POSTER 750-52	Antifreeze/Battery Tester
DA POSTER 750-54	Dry Cell Battery Tester AN/PSM-13
DA POSTER 750-58	Tach-Dwell Meter
DA POSTER 750-50	Low-Voltage Circuit Tester
DA POSTER 750-56	Vacuum Gage
DA POSTER 750-55	Multimeter AN/URM-105
DA POSTER 750-57	Timing Light
DA POSTER 750-51	Spark Plug Cleaner-Tester

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YOU TOO CAN BECOME A . . .

UNIT DIAGNOSTICIAN

RX

Ever get frustrated when . . .

Your rig's lights won't work?

Or the battery won't turn over the engine?

Or the generator won't kick out enough juice?

Or your engine spits and sputters, coughs, lacks go-power?

Or you're not certain of the life left in your PRC-25 radio's battery?

Some people, when caught with these or similar equipment failures, have no shame. They leap right in and start yanking and replacing components until the problem's solved. Or until they throw up their hands in utter hopelessness when all the new parts don't fix the trouble.

Either way, a lot of good and useful parts get tossed aside, and many find their way to the scrap heap. Or they clog the supply pipeline when they're shuttled up to support for repair—where they're checked out and found to be serviceable.

It's the hit-and-miss or trial-and-error type of repair that runs parts costs and maintenance down-time sky high. And it points to a diagnostic method that's for the birds.

HEY, YOU DIAGNOSTICIAN TYPES! EYEBALLS HERE...

If you haven't yet won the "Order-of-the-Bolt with Crossed-Threads" for expert troubleshooting, maybe all you need is to brush up on working the diagnostic equipment that's holed up within your reach.

DIAGNOSTIC EQUIPMENT??

Yes! That's just the test equipment that's resting on the shelf in every unit's tool cage. It comes in tool sets or is provided by your TOE.

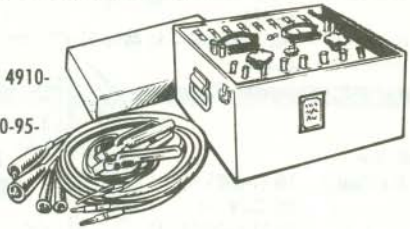
That test equipment can short-cut your troubleshooting chase and lead you straight to the trouble source.

To qualify for the title of "Unit Diagnostician," brush up on the most common test equipment—equipment like .....

NEXT PAGE

HERE'S THE TEST EQUIPMENT AND KNOW-HOW THAT'LL PUT YOU IN THE GROOVE . . .

LOW-VOLTAGE-CIRCUIT TESTER (TEST SET, GENERATOR AND VOLTAGE REGULATOR) FSN 4910-092-9136 OR 4910-270-3780



Found In Tool Sets .....No. 1 Supplemental—SC 4910-95-CL-A73
No. 2 Common—SC 4910-95-CL-A72

Tell How It's Used ..... TM 9-4910-456-14 (Model 30-92)
TM 9-4910-472-10 (Model VAT-25)
Equipment's -20 TM (like TM 9-2320-218-20 Section VI) Training Film 9-3536

Used For .....Testing the voltage setting, and amperage draw of the starter, battery, generator, alternator, and voltage regulator on all internal combustion engines. When used on 24-volt waterproof electrical systems, Adapter Kit FSN 4910-348-7600 is needed.

Test Prevents .....Unnecessary replacement of good starters, generators, alternators, switches, regulators, wiring cables and other charging system electrical components.

TEST SET, TACHOMETER & CAM DWELL: FSN 4910-788-8549

Found In Tool Sets .....No. 1 Supplemental—SC 4910-95-CL-A73
No. 2 Common—SC 4910-95-CL-A72

Tell How It's Used .....TM 9-4910-416-12
Training Film 9-2193

Used For .....All gasoline engines to test or set the gap setting on the distributor points and the engine RPM.

Test Prevents .....Changing coil, distributor, spark plugs and other parts of the ignition system unnecessarily.

MULTIMETER:
FSN 6625-543-1438 (SIMPSON TYPE OR TRIPLETT 666HH)
FSN 6625-975-4482 (TRIPLETT 666RW)
FSN 6625-553-0142 (TS-352B/U)
FSN 6625-581-2036 (AN/URM-105)

Found In Tool Sets ..... No. 1 Common—SC 4910-95-CL-A74
No. 2 Common—SC 4910-95-CL-A72
Separate TOE item

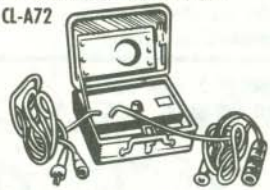
Tell How It's Used ..... TM 11-6625-366-15 (TS-3528/U)
TM 11-6625-203-12 (AN/URM-105)
Equipment's -20 TM (like TM-9 2320-218-20, Section VI)
Training Film 11-1667

Used For ..... Testing and checking AC and DC voltages. And switches, batteries, alternators, lamps, cable connections, starters, wiring harnesses, etc., for continuity (open or short circuit). Also to test and check the resistance of various electrical components and circuits.

Test Prevents ..... All of the mentioned items from being removed as faulty when they are not.

LIGHT, IGNITION TIMING:
FSN 4910-937-5724

Found In Tool Sets ..... No. 1 Common—SC 4910-95-CL-A74
No. 2 Common—SC 4910-95-CL-A72



Tell How It's Used ..... Vehicle/equipment -20 TM like TM 9-2320-218-20 (page 2-63)
Training Film 9-2194

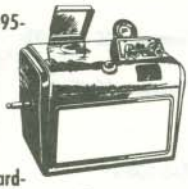
Used For ..... Testing and setting ignition timing on most gasoline engines. One of the tests made when the engine spits and sputters.

Test Prevents ..... Unnecessary changing of distributor points, spark plugs, ignition coil and even wiring harnesses.

SPARK PLUG TESTER AND CLEANER: FSN 4910-261-5868

Found In
Tool Sets .....No. 1 Supplemental—SC 4910-95-CL-A73
No. 2 Common—SC 4910-95-CL-A72

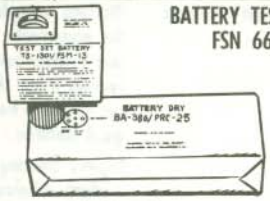
Tell How
It's Used ..... TM 9-4910-389-20P



Test Prevents .....Throwing away good and hard-to-get spark plugs that have life left in them.

Used .....To test and clean spark plugs used in gasoline engines.

BATTERY TEST SET AN/PSM-13: FSN 6625-868-8344



Found In .....SB 11-623

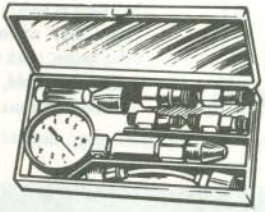
Tell How
It's Used .....TM 11-6625-823-15

Test Prevents .....Throwing away good batteries that have many more hours of useful life. And keeps you from moving out on a mission with short-life batteries.

Used For .....Testing the batteries used in these radios: AN/PRC-6, 8, 9, 10, 25, 74, 77; AN/PRR-9, AN/PRT-4.
By battery number they are: BA-270/U, BA-279/U, BA-376/U, BA-377/U, BA-386/PRC-25, BA-398/PRC-25, BA-399/U and BA-505/U, BA-4386/PRC-25

CYLINDER, COMPRESSION GAGE: FSN 4910-250-2423

Found In
Tool Sets .....No. 1 Common—SC 4910-95-CL-A74
No. 2 Common—SC 4910-95-CL-A72



Tell How
It's Used .....TM 9-4910-430-10
TM 9-4910-433-10
Training Film 9-2194

Used For .....Testing all gasoline engines cylinders for the right pound per square inch pressure. It'll indicate which cylinder has bad rings, valves or leaky gasket.

Test Prevents .....Pulling and changing the carburetor, distributor, fuel pump etc., unnecessarily when engine cranks but fails to start due to low cylinder compression.

ANTI-FREEZE BATTERY TESTER

FSN 6630-105-1418

Found In

Tool Sets .....No. 1 Common—SC 4910-95-CL-A74
No. 2 Common—SC 4910-95-CL-A72

Tell How

It's Used .....TM 9-6140-200-14
TB 750-651
PS 244

Used For .....Testing the specific gravity (battery charge) of the electrolyte (sulfuric acid and water solution) of lead-acid batteries. Lets you know which cell is bad, and when the battery needs charging.

Testing specific gravity of anti-freeze and water solution in engines having a liquid-type cooling system.

Test Prevents .....Working or replacing parts on the equipment's charging system when the battery is at fault. Leaving a low charged battery out in cold to freeze. Scrapping good batteries.

Engines freezing up or block cracking in below freezing ambient temperatures.

INTERNAL COMBUSTION ENGINE GAGE: (VACUUM/FUEL PUMP GAGE)

FSN 4910-255-8673

Found In

Tool Sets .....No. 1 Common—SC 4910-95-CL-A74
No. 2 Common—SC 4910-95-CL-A72
No. 2 Supplemental—SC 4940-95-CL-A08

Tell How

It's Used .....TM 9-4910-477-10 and every vehicle -20 TM.
Training Film 9-2194

Used For .....Checking the engine manifold vacuum and fuel pump pressure. It's a trouble-shooting aid to pin-point gasoline engine malfunctions like bad head gasket, worn or poorly fitted piston rings, poor carburetion, bad valve timing, stuck valves, leaks in intake manifold, clogged fuel line and a lot more.

Test Prevents .....Pulling and switching the carburetor, fuel pump, spark plugs, distributor because you think the trouble is in those components.

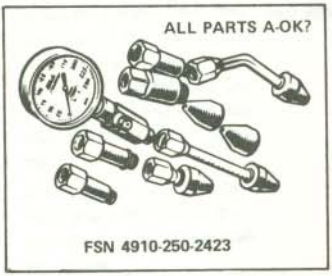
NOTES

250-908 O - 77 - 2

GASOLINE ENGINES

FIRST ...

1



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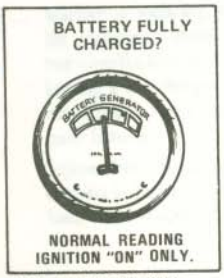
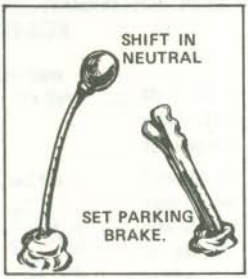


LOW BATTERIES WILL NOT TURN OVER ENGINE AT MAXIMUM RPM

3

4

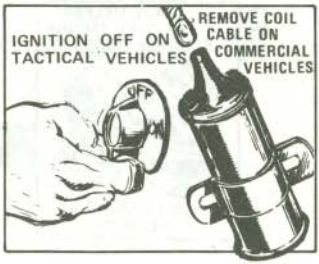


5

TEST ON DIESEL ENGINES IS A DSU JOB -- LEAVE IT TO 'EM.

GET READY ...

6



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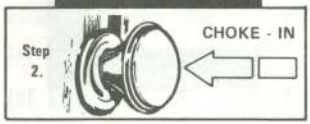


8

LOOSEN - BLOW OUT

SPARK PLUGS

9

REMOVE - CLEAN HOLES

10

DRY TEST ...

11 WITH GAGE ATTACHED TO NO. 1 CYLINDER. . .

12 . . .HAVE HELPER TURN OVER ENGINE ABOUT 10 REVS.

DON'T OVERHEAT STARTER

13 READ YOUR GAGE

WRITE IT DOWN ON YOUR FORM 2404

14 **DO ALL OTHER CYLINDERS THE SAME.**

* * * *

ZERO GAGE AND CLEAN TIP AFTER EACH CYLINDER TEST.

* * * *

SAMPLE READINGS M151

CYL	1	2	3	4
PSI	115	125	120	100

15 COMPRESSION LIMITS FOR TACTICAL GASOLINE ENGINES

Vehicle Series	Allowable Minimum	Maximum Allowable Variation Between Low & High Cylinder
M151 ¼-ton series	85 PSI	25 PSI
M37 ¾-ton series	110 PSI	10 PSI
M715 1¼-ton series	120 PSI	15 PSI
M35 2½-ton series	90 PSI	10 PSI
M54 5-ton series	110 PSI	10 PSI
M123 10-ton series	100 PSI	10 PSI
M113 Carrier series	110 PSI	20 PSI

READINGS BELOW MINIMUM OR BEYOND MAXIMUM ALLOWABLE VARIATION. . .

CAUSE & CURE :

1. HEAD GASKET BLOWN

LOOK FOR SIGNS OF LEAKAGE. IF ANY, REPLACE GASKET IF MAC' SAYS SO.

2. BAD RINGS

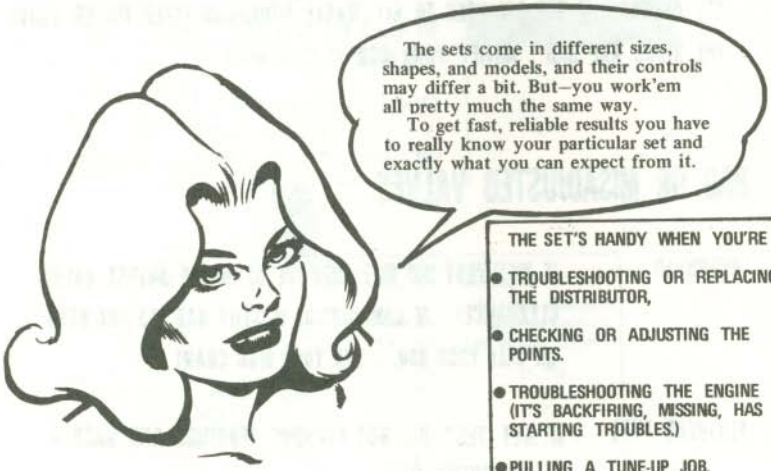
WET TEST EACH CYLINDER. DO THE SAME AS FOR A DRY TEST, BUT BEFORE SCREWING IN THE GAGE , SQUIRT A LITTLE OIL ON THE CYLINDER WALL -- ALL AROUND. IF THE PSI GOES TO ALLOWABLE MINIMUMS (STEP 15) OR ABOVE, THE RINGS ARE BAD. NOTIFY YOUR DSU.

3. BAD OR MISADJUSTED VALVES

OVERHEAD -- IF WET TEST DID NOT IMPROVE READINGS ADJUST VALVE CLEARANCES. IF COMPRESSION IS STILL BAD, DX THE HEAD OR CALL YOUR DSU. . .PER YOUR MAC CHART.

FLATHEAD TYPE -- IF WET TEST DID NOT IMPROVE READINGS AND GASKET IS OK, NOTIFY DSU.

THE TACH-DWELL TEST SET



THE SET'S HANDY WHEN YOU'RE

- **TROUBLESHOOTING OR REPLACING THE DISTRIBUTOR,**
- **CHECKING OR ADJUSTING THE POINTS.**
- **TROUBLESHOOTING THE ENGINE (IT'S BACKFIRING, MISSING, HAS STARTING TROUBLES.)**
- **PULLING A TUNE-UP JOB.**
- **TIMING THE ENGINE.**

IN GENERAL HERE'S HOW THE BOX WORKS. . .

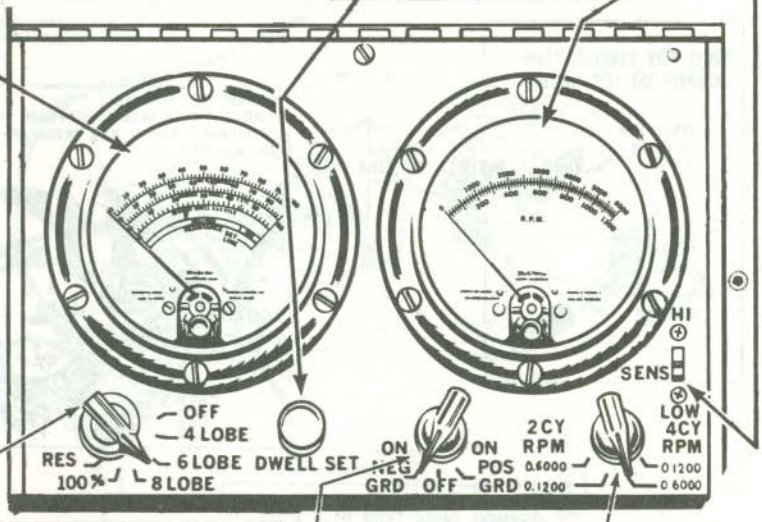
DWELL METER—Gives the distributor cam dwell reading. It may be a single-scale meter (0 to 50 degrees), or, a multi-scale meter. you have to calibrate the multi-scale meter (with its dwell set button), to a specified set-line (starting point) for type of engine (4, 6 or 8 cylinders) you're working on.

The multi-scale meter has 3 scales for taking dwell readings, and a red-green (GO-NO GO) scale for testing point resistance. This scale also tattles on other power-flow problems between the battery and the distributor (low battery, burn ground, broken wires or connections, etc.).

SENSITIVITY SWITCH—Keep it on Low. Only time you flip switch to HIGH is so's you can operate tachmeter when spark plug voltage is low.

TACH METER—Gives engine RPM. It covers 2 RPM ranges:
Minimum 0-1000 (or 1200 depending on your set) RPM.
Maximum 0-5000 (or 6000 depending on your set) RPM.

DWELL SET SWITCH (on multi-scale dwell meters)—For calibrating the meter, and spotting the set-line.



LOBE SELECTOR SWITCH—It lines up the dwell meter with the engine you're checking. You set it to match the number of cylinders—4, 6, or 8, on the engine.

If your set has a multi-scale dwell meter, flip this switch to RES, when you go to pull a point resistance check.

GROUND SELECTOR SWITCH—This matches the set's polarity to the polarity of the vehicle you're checking. (Some sets call it the polarity selector switch).

It has a negative and a positive setting, and it may also serve as the ON-OFF power switch for the set.

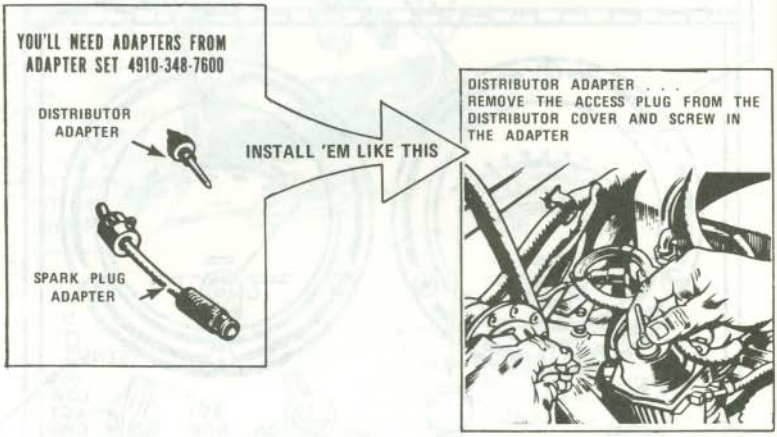
SPEED (OR ACH) SELECTOR SWITCH—Set it to match the type of engine (2- or 4-cycle) you're testing, and to the RPM range you'll need.

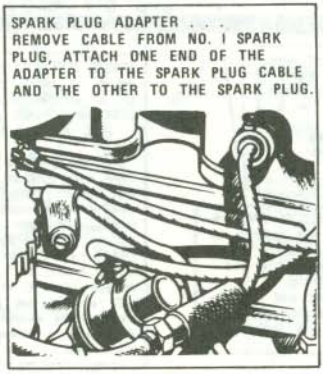
And, here's a big, fat caution on this switch—

Always set the switch on maximum RPM when you start the engine. After the engine's idling you can set the switch on minimum RPM, if that's the range you'll need. But, never start the engine with the tach switch on minimum RPM. Even if you're real light-footed, you're bound to race the engine a bit as you start it, and the meter's needle will ram the peg on its right as the engine RPM exceeds the meter's range. And, once a needle's pegged it'll not work right.

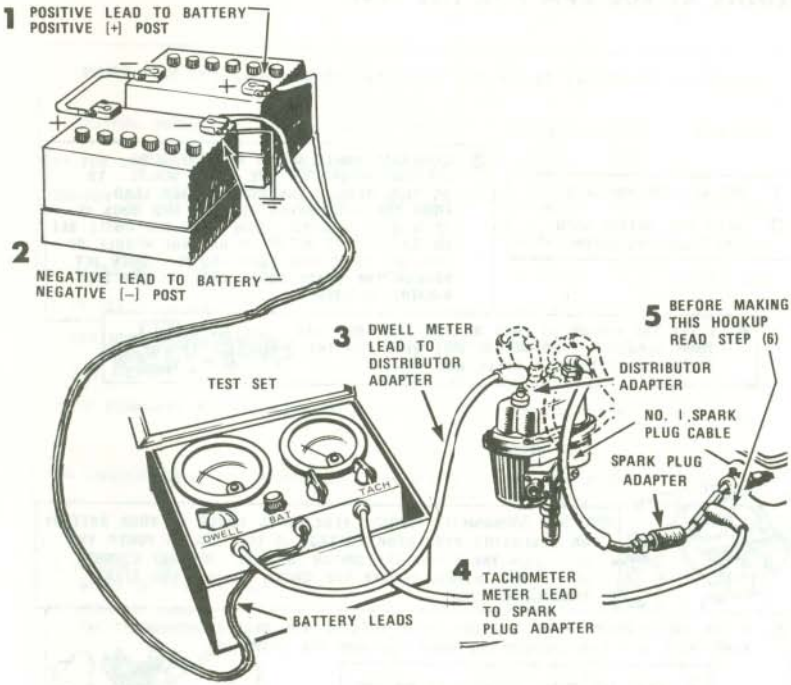
POWER SWITCH—Some sets have a separate ON-OFF power (toggle) switch. On other sets you control the ON-OFF power with the ground (polarity) switch.

ON WATERPROOF IGNITION SYSTEMS . . .





HOOK UP BOX LIKE THIS. . .



6 --TACHOMETER LEAD HOOKUP--

--IF YOUR TEST SET HAS A SPLIT-SLEEVE CLAMP ON ITS TACH LEAD. NEVER HOOK IT UP TO THE TERMINAL OF THE SPARK PLUG ADAPTER--
--JUST CLAMP THE SPLIT--SLEEVE CLAMP OVER THE ADAPTER'S INSULATED WIRE . . . AND TAKE CARE THE CLAMP DOESN'T TOUCH ANY OTHER COMPONENT ON THE ENGINE.

YOU HOOK UP TO THE TERMINAL ON THE ADAPTER ONLY WHEN YOUR SET HAS A HEAVY TACH LEAD WITH A SMALL ALLIGATOR-TYPE CLAMP.

MAKING THE TEST. . .

ENGINE AT 800 RPM FOR THE TEST

1 SET ALL THE SWITCHES.

2 ZERO THE METERS WITH THE ADJUSTING SCREW.

3 CALIBRATE DWELL METER AND ESTABLISH SET LINE (SHOWN ON THE METER SCALE). TO DO THIS, REMOVE THE DWELL METER LEAD FROM THE DISTRIBUTOR ADAPTER AND HOOK IT TO A GOOD GROUND. NOW TURN THE DWELL SET SWITCH LEFT OR RIGHT TO GET THE NEEDLE ON THE "SET LINE" FOR YOUR ENGINE. WHEN SET REHOOK THE DWELL METER LEAD TO THE DISTRIBUTOR ADAPTER.

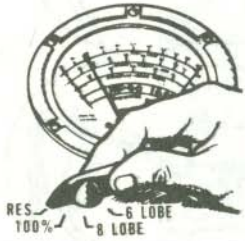
4 START THE ENGINE AS EASY AS YOU CAN AND TAKE YOUR READINGS. THE METERS WILL GIVE YOU THE SCORE ON DISTRIBUTOR DWELL AND RPM.

5 IF THE TACHOMETER POINTER FLUCTUATES, COULD BE YOUR BATTERY OR GENERATOR–REGULATOR VOLTAGE IS TOO LOW TO POWER THE SET. FLIP THE SENSITIVITY SWITCH TO HIGH. IF THAT DOESN'T SETTLE THE NEEDLE, RETURN THE SWITCH TO LOW, AND START TROUBLESHOOTING.

6 IF THE DWELL METER GIVES YOU THE RIGHT READING, THE NEEDLE SHOULDN'T VARY MORE 'N A FEW DEGREES (AS WHEN YOU GUN THE ENGINE.)

7 TAKE THE DWELL READING AT 800 RPM.

POINT RESISTANCE TEST



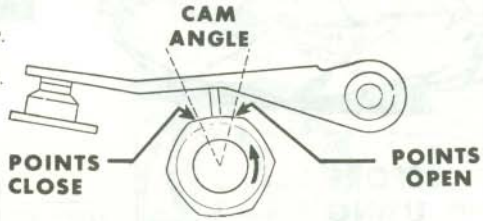
1. ENGINE OFF.
2. BREAKER POINTS CLOSED.
3. IGNITION SWITCH ON.
4. FLIP LOBE SWITCH TO RES.
5. READ GO NO-GO GAGE.
6. IF NO-GO, TURN OFF IGNITION.
7. CHECK POINTS, CAN BE PITTED, BURNED, ETC.
8. IF POINTS ARE OK, CHECK CIRCUIT FROM BATTERY.

HERE ARE THE CAM-DWELL ANGLES FOR MOST TACTICAL VEHICLES.

TACTICAL VEHICLES	DISTRIBUTOR	MAKE	CAM DWELL ANGLE	POINT GAP
1/4-TON M151-SERIES	1AU-4020-UT	AUTO-LITE	39-46°	0.017 - .022
3/4-TON M37-SERIES	1AU-4005-UT	AUTO-LITE	37-40°	0.020 ± 0.002
	1AU-4007-UT	AUTO-LITE	37-40°	0.020 ± 0.002
1 1/4-TON M715-SERIES	1DA-4601-UT	PRESTOLITE	38-44°	0.020 ± 0.002
2 1/2-TON M35-SERIES	1111556	DELCO-REMY	31-37°	0.022
5-TON M54-SERIES	1111556	DELCO-REMY	31-37°	0.022
10-TON M123-SERIES	1111605	DELCO-REMY	28-30°	0.016 - 0.019
XM706 COMMANDO CAR	1DA-4801-UT	PRESTOLITE	ONE SET 27-30° BOTH 34-40°	0.016 - 0.021
M113 CARRIER SERIES	1BF-4004-UT	AUTO-LITE	ONE SET 27-30° BOTH SETS 34-40° (AT 1000 RPM)	0.016 - 0.021

TO INCREASE ANGLE . . .
DECREASE BREAKER POINT GAP.

TO DECREASE ANGLE . . .
INCREASE BREAKER POINT GAP.



THE ANGLE AT WHICH POINTS REMAIN CLOSED IS CALLED "CAM" OR "DWELL ANGLE"

250-908 O - 77 - 3

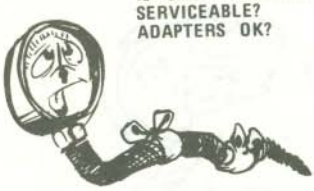
HOW TO USE YOUR VACUUM GAGE

INTERNAL COMBUSTION ENGINE GAGE

in Tool Sets . . .
No. 1 Common — SC 4910-95-CL-A74
No. 2 Common — SC 4910-95-CL-A72
No. 2 Supplemental — SC 4940-95-CL-A08

BEFORE USING

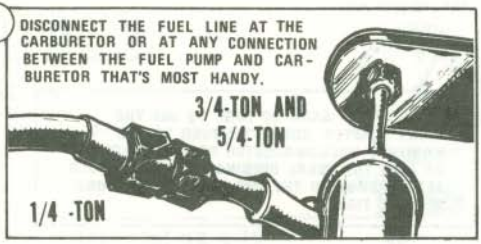
IS GAGE CALIBRATED?
SERVICEABLE?
ADAPTERS OK?



TEST WITH VEHICLE'S – 20 TM IN HAND. LOOK FOR SPECIFIC INSTRUCTIONS.

FUEL PUMP TEST ...

1 DISCONNECT THE FUEL LINE AT THE CARBURETOR OR AT ANY CONNECTION BETWEEN THE FUEL PUMP AND CARBURETOR THAT'S MOST HANDY.

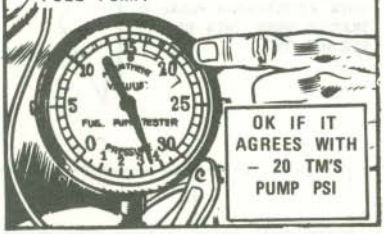


2 WITH AN ADAPTER, CONNECT THE GAGE TO THE FUEL LINE COMING FROM THE PUMP.

3 START ENGINE (IT'LL RUN ON FUEL LEFT IN THE CARBURETOR) OR HAVE IT CRANKED WITH THE STARTER.

4 NOW READ THE PSI ON THE GAGE'S BOTTOM SCALE.

5 IF IT DOESN'T AGREE CHECK FOR CLOGGED FUEL LINES. IF LINES ARE CLEAR, REPLACE FUEL PUMP.



VACUUM TEST ...

1 IF YOUR VEHICLE HAS A COMBINATION FUEL AND VACUUM BOOSTER PUMP YOU'LL HAVE TO DISCONNECT FROM THE MANIFOLD. ATTACH ADAPTER DIRECTLY TO OPENING AT BACK OF MANIFOLD AND CONNECT GAGE TO ADAPTER. PLUG THE END OF VACUUM PUMP LINE WITH TAPE.

VACUUM–BOOSTER PUMPS ARE ONLY MOUNTED ON VEHICLES HAVING VACUUM WINDSHIELD WIPERS . . . LIKE THE M151 AND M151A1.

VACUUM TEST (continued)

2

HOOK UP THE GAGE. BE SURE TO USE THE RIGHT ADAPTER. CONNECT EITHER TO THE MANIFOLD VACUUM-BOOSTER PUMP CONNECTION OR INTO THE USUAL OPENING IN THE MANIFOLD AFTER REMOVING THE PIPE-PLUG. CONNECTIONS MUST BE TIGHT.

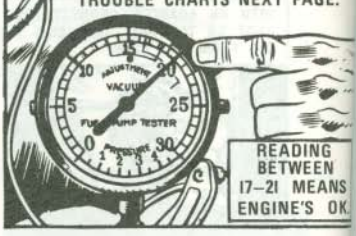
3

RUN THE ENGINE AND BRING IT UP TO ITS MINIMUM OPERATING TEMPERATURE (UNTIL THE TEMP GAGE NEEDLE BEGINS TO MOVE).

4

ENGINE AT IDLE (600 RPM)

IF NOT BETWEEN 17-21, SEE TROUBLE CHARTS NEXT PAGE.



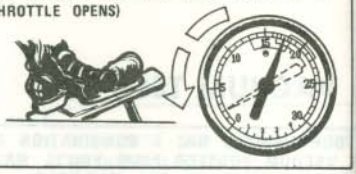
NOT OVER ± 1" FLUCTUATION. ADJUST CARB MIXTURE SCREW FOR HIGHEST READING.

THROTTLE TEST ...

IF GAGE REACTS LIKE THIS WHEN ACCELERATOR PEDAL IS SNAPPED DOWN, THEN UP . . . ENGINE'S OK.

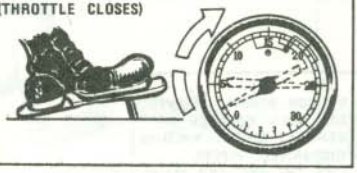
1

SNAP DOWN. . . SHOULD DROP TO ABOUT 2" (THROTTLE OPENS)



2

SNAP UP . . . JUMPS UP TO ABOUT 22–25 (THROTTLE CLOSES)



3

THEN BACK TO ORIGINAL SETTING

TROUBLE

TM 9-4910-477-10 (JAN 67)
GIVES THE FINE POINTS ON
USING THE VACUUM GAGE.

LOW STEADY NEEDLE

BETWEEN 17" & 2"

COULD MEAN . . .	TEST FURTHER WITH . . .	DO . . .
1. BAD TIMING	a. TACH DWELL METER	a. REPLACE DISTRIBUTOR.
	b. TIMING LIGHT	b. ADJUST TIMING.
2. INTAKE MANIFOLD LEAKS	LOOK FOR LEAK - USE OIL	a. TIGHTEN BOLTS AT LEAK.
		b. REPLACE LEAKING VACUUM LINES.
		c. REPLACE INTAKE MANIFOLD GASKET.
3. POOR COMPRESSION	COMPRESSION GAGE	a. REPLACE HEAD GASKET IF MAC* SAYS IT'S OK.
		b. IF NOT NOTIFY DSU.
4. LOOSE VALVE GUIDES	COMPRESSION GAGE	a. REPLACE IF MAC* SAYS SO.
		b. IF NOT NOTIFY DSU.

NEEDLE FLUCTUATING

BETWEEN 17" & 5" (MORE THAN 2" OR 3")

COULD MEAN . . .	TEST FURTHER WITH . . .	DO . . .
1. BAD SPARK PLUGS	SPARK PLUG TESTER	CLEAN, TEST OR REPLACE.
2. BAD SPARK PLUG WIRING	MULTIMETER	REPLACE IF FAULTY.
3. BAD CARBURETOR	LOOK IT OVER FOR CRACKS, EXCESSIVE GUM. DIRT OR GAS LEAKAGE.	REPLACE IF FAULTY.
4. TIMING OFF	TIMING LIGHT	ADJUST TIMING.
5. HEAD GASKET BLOWN	COMPRESSION GAGE	a. REPLACE IF MAC* SAYS SO.
		b. IF NOT NOTIFY DSU.
6. BAD PISTON	COMPRESSION GAGE	NOTIFY DS MAINTENANCE.

ALTITUDE AFFECTS READINGS -- DEDUCT 1 INCH FOR EVERY 1,000 FEET ABOVE SEA LEVEL.

*MAINTENANCE ALLOCATION CHART IN YOUR -20TM.

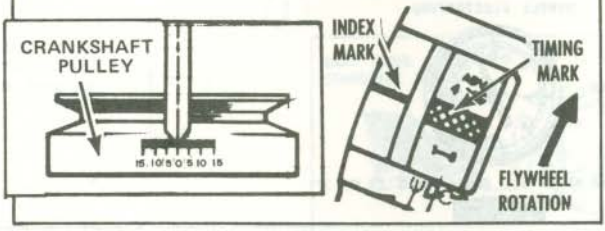
USING YOUR TIMING LIGHT

BEFORE HOOKING UP. . .

1 CHECK CAM DWELL ANGLE - - GAP AND ADJUST POINTS IF NEEDED.

FOR CAM DWELL CHECK, SEE TACH-DWELL TEST CHART.

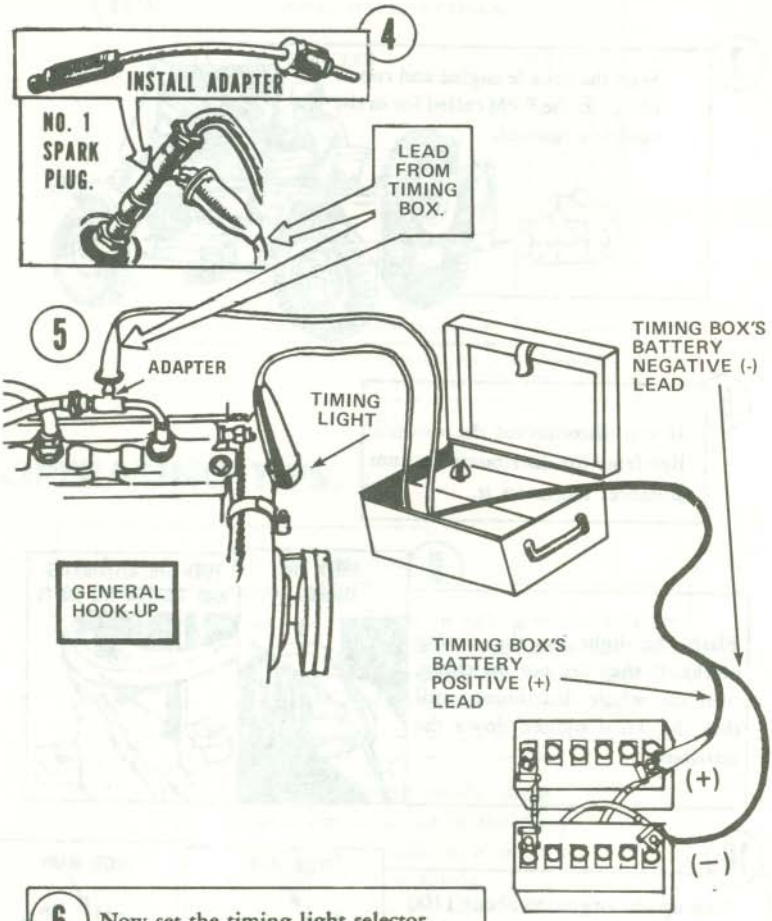
2 FIND & CHALK TIMING MARKS



3

Find a safe place to stand and a spot to hold the light while it flashes on the damper — clear of the whirling fan.

HOOKING UP. . .



6 Now set the timing light selector switch to 24 volts.

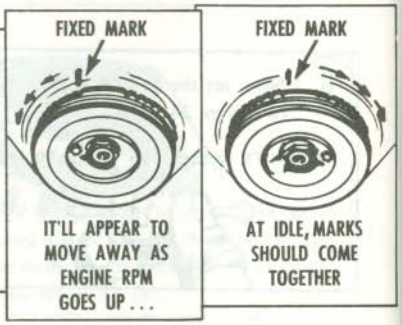
TIMING. . .

7 Start the vehicle engine and run at idle or at the RPM called for in the vehicle's manual.

8 If you disconnected the vacuum line from the distributor vacuum advance, reconnect it.

9 Flash the light on the timing marks. If they are not matching, turn the whole distributor until they do. Then tighten down the distributor.

10 Step up the engine to about 1100 RPM. Watch the timing mark—it will appear to move away from the fixed timing pointer. When you drop to idle they should go back together. If they don't behave this way then it's a job for your support.



11

TIMING MARK SETTINGS

TACTICAL VEHICLES	SETTING
¼-Ton M151-series	6° BTDC
¾ Ton M37-series	2° BTDC
1¼-Ton M715-series	5° BTDC
2½-Ton M35-series	4° BTDC
5-Ton M54-series	5° BTDC
10-Ton M123-series	4° BTDC
M113 Carrier-series	10° BTDC

Extreme high altitudes will change (retard) the above settings. See your DSU for the exact degrees from TDC that'll meet the conditions of your area.

For other spark-ignition engines .see equipment's -20 TM.

OPERATING TIPS. . .

1. If the flash tube gets hot, don't worry — it's normal.

2. When the light gives extra flashes, your spark plug lead is too close to other plugs. Re-route it until it'll only respond to No. 1 plug.

3. When the timing marks jump around, the cause can be the distributor gap, condensor, rotor or weak point tension spring.

4. When the line looks like a blur — or an inch wide — the cause may be a worn distributor shaft, weak governor springs, or a loose connection in the primary circuit between the battery and distributor.

USING YOUR... SPARK PLUG CLEANER AND TESTER

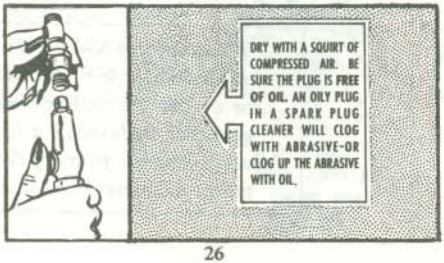
OPERATING AIR PRESSURE: MINIMUM 100 PSI

FIRST. . .
EYEBALL THEM FOR:

1. Chipped or cracked insulators (In barrel or base)
2. Crossed threads
3. Mashed or bent barrel
4. Bent center electrode
5. Electrode burned halfway through

FIND ANY?
TOSS 'EM OUT!

THE GOOD ONES . . .



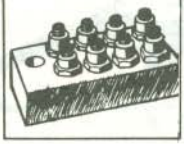
NOW SANDBLAST 'EM . . . . .
CAREFUL--WEAR GOGGLES

1 Now you put the plug in the rubber adapter of the spark plug cleaner . . . be sure the adapter's the right size. The right one fits nice 'n'tight . . . most adapters are marked for size . . . so check first.

2 Put your finger on top of the plug, and swing it in a one-inch circle while pressing the abrasive blast valve of the cleaner . . . A three second blast is enough.

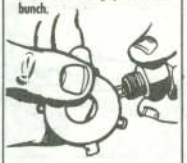
3 After each 3-second blast . . . press the air blast valve for about a second . . . be careful not to thrust plug in the adapter.

4 Clean all the plugs from one engine at one run. That way they don't get mixed with plugs from some other engine. Keep them in racks as you go.



5 A flat-face ignition-point file helps dress plug electrodes — but no major surgery.

6 When you get a set of plugs blast-cleaned, gap-test the bunch.



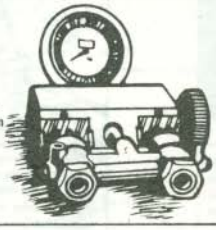
Round-wire gap gages beat the flat kind.

TESTING . . . . .

You can find plug adapter set FSN 4910-348-7600 in your No. 1 Common Tool Set.

1

Use the metal adapter to fit your plug. Screw up finger tight, no more.
Set the gap gage dial. Use setting from your vehicle TM.



2 Get a new plug of the same type

3

Put the new plug, correctly gapped, in the tester. Use either hole.

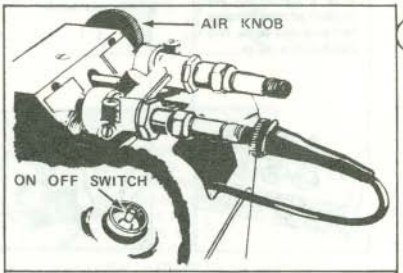
4

Close the other hole of the tester with the plug you're gonna test.....

5

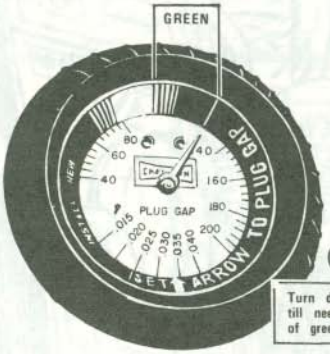
Put the tester electrode on the new plug....

6



Turn on air and push ON-OFF switch.

7 Increase air until plug stops sparking..... Then back it down to highest pressure at which plug fires with a steady spark.

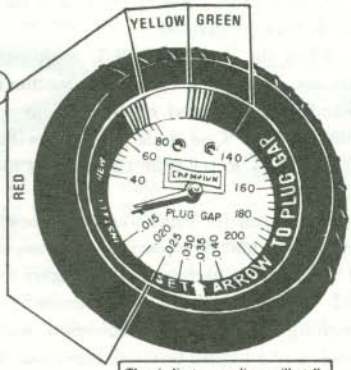


8 Turn dial of spark indicator till needle is on right edge of green. Do not move dial.

9

Put electrode on old plug. Repeat Step 7 for steady spark.

10



The indicator reading will tell good (green), fair (yellow) or replace (red).

AFTER 350 PLUGS--REPLACE
BLAST NOZZLE AND ABRASIVE (GRAIN),
FSN 5350-222-0581

VARIOUS MAKES AND MODELS OF THE CLEANER-TESTER WORK ABOUT THE SAME WAY

YOUR TS-352 B

A man usually steers clear of a thing he doesn't understand.

When the first TS-352B/U multimeter arrives in shop a couple of mechanics stand well back and regard it with suspicious eyes. One dude prods it with a forked stick to see if he can make it snap back.

But for all its snake-like leads, beady-eyed jacks and bewildering switches, the TS-352B/U is harmless—and mighty useful. As far as you're concerned it's nothing more than a volt-ohm meter packed in a rugged box—an ingenious device for troubleshooting 28-volt electrical circuits.

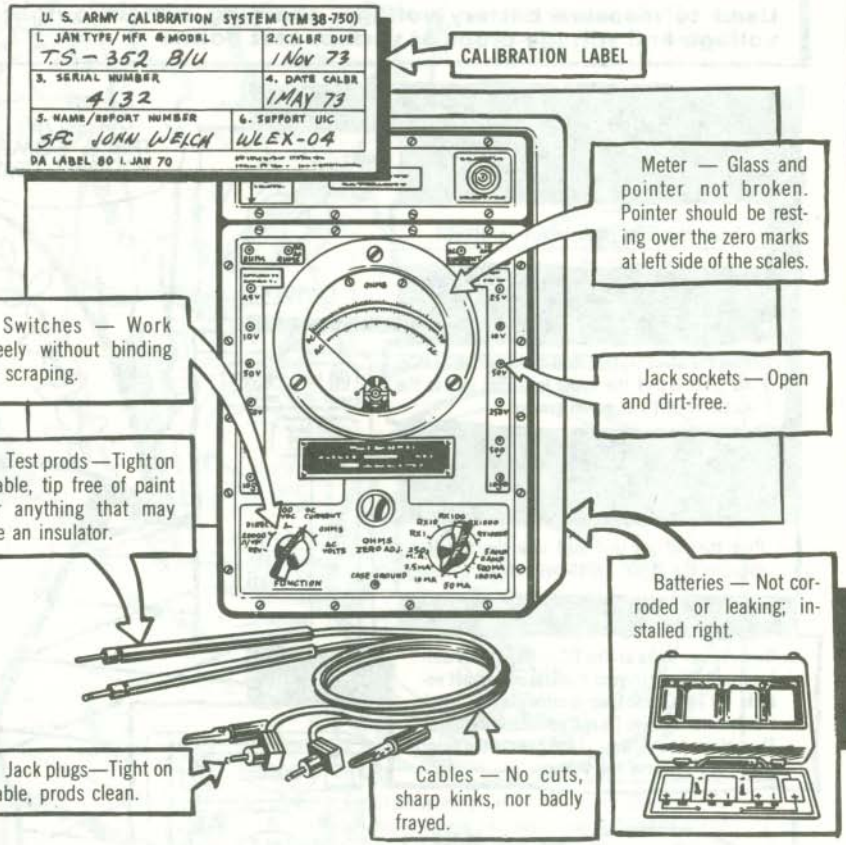
Using it is your better way to cure an ailing electrical system. It's lots better than blindly replacing alternators, switches, bulbs, batteries and wiring harnesses in the hope that the trouble will disappear.

Several automotive -20 TM's give good rundowns on checking out automotive circuits with a less complicated-looking commercial type multimeter. But since the TS-352B/U, a military design job, is about the only meter available in your automotive maintenance organizational No. 1 and No. 2 common tool sets, it's time to dispel any hocus-pocus beliefs that keep you from using it.

When making voltage, resistance and continuity tests that're spelled out in your automotive -20 TM's, rig your TS-352B/U multimeter like this . . .

FIRST THINGS FIRST

Before using the multimeter make certain it's been calibrated in the last 6 months. Then give it a hawk eye to see if it's in working order. Like . . .



AT EASE

Don't let the many jack and switch positions throw you. Although the TS-352/BU is made for testing a wide range of electrical and electronic circuits, you can ignore most of them when it comes to dealing with 28-volt DC automotive electrical circuits. You can make all your voltage, resistance and continuity tests with only a few jack and switch positions.

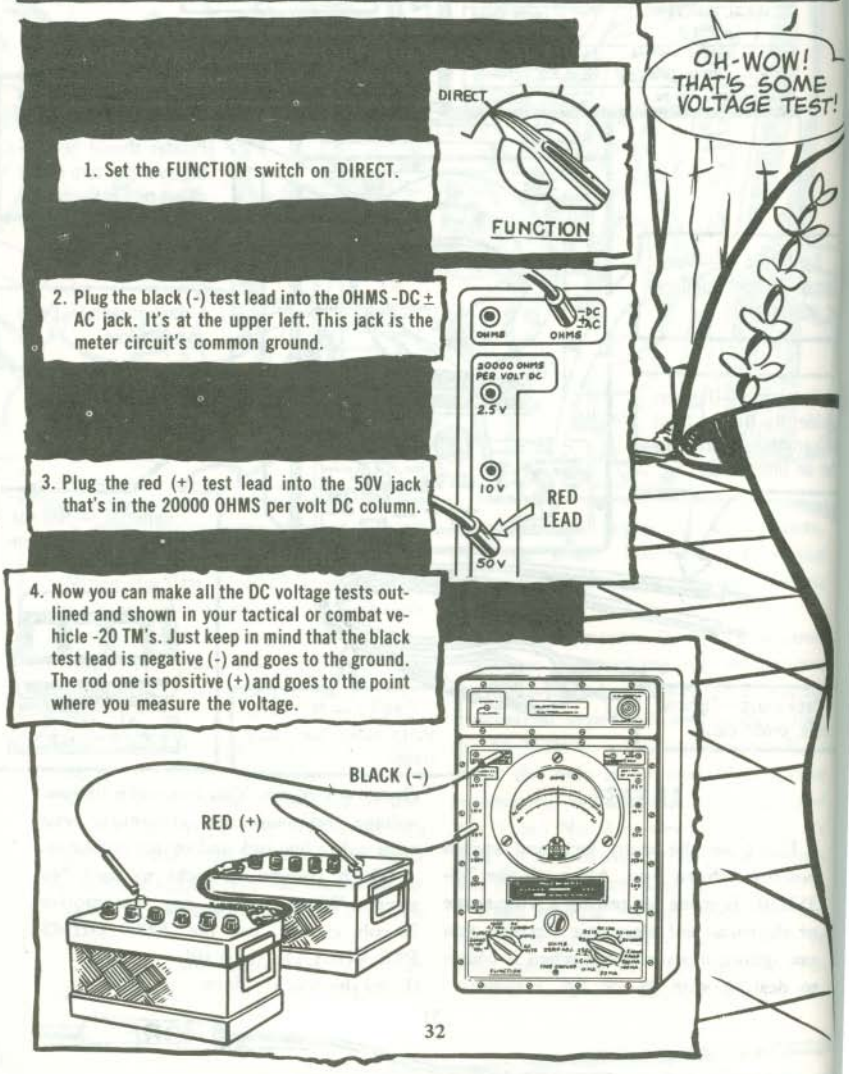
Which column of jacks to use? No sweat. When testing any automotive 28-volt circuit, use the 20000 OHMS PER VOLT DC (left) side.

Here's the way it's done . . .

MORE

DC VOLTAGE TESTS

Used to measure battery voltage, charging system output voltage and voltage drops at various test points

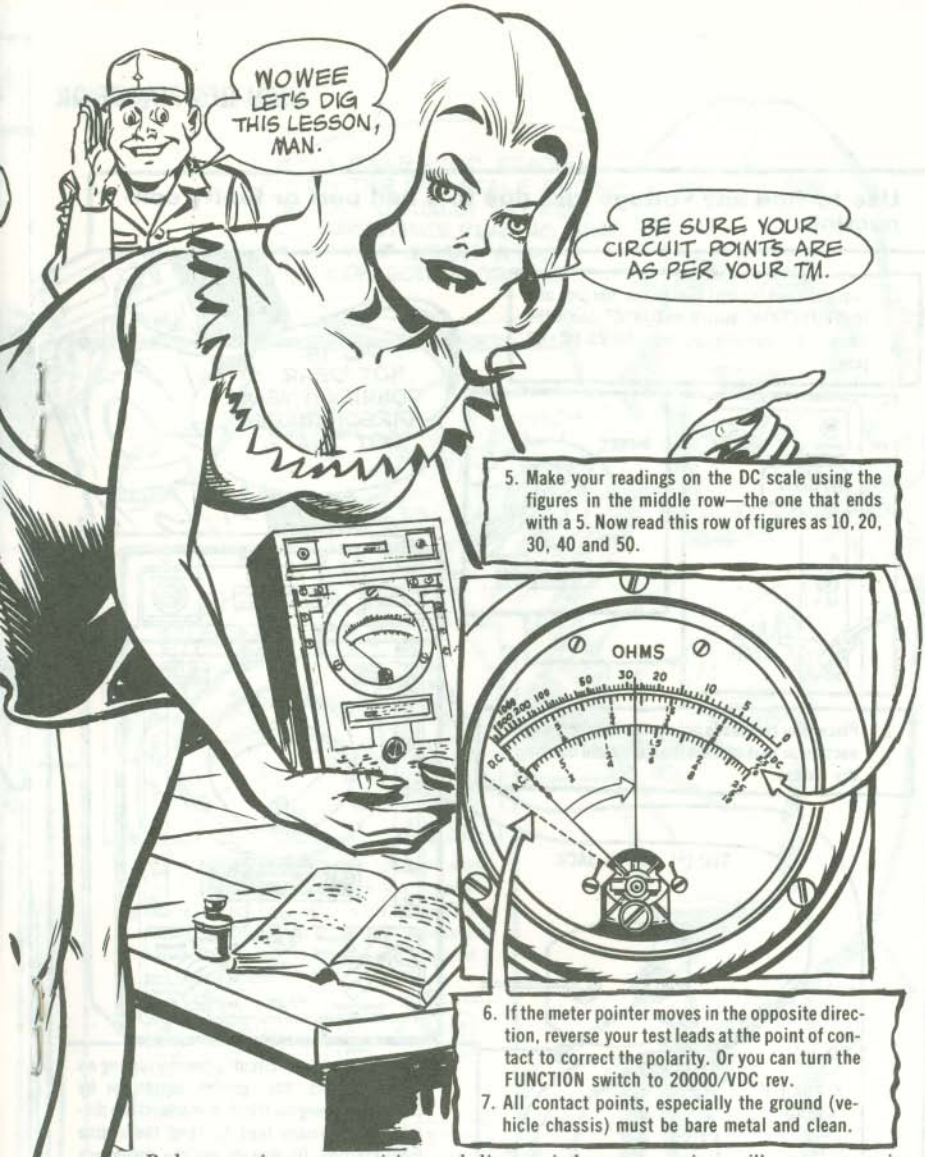


1. Set the FUNCTION switch on DIRECT.

2. Plug the black (-) test lead into the OHMS -DC ± AC jack. It's at the upper left. This jack is the meter circuit's common ground.

3. Plug the red (+) test lead into the 50V jack that's in the 20000 OHMS per volt DC column.

4. Now you can make all the DC voltage tests outlined and shown in your tactical or combat vehicle -20 TM's. Just keep in mind that the black test lead is negative (-) and goes to the ground. The rod one is positive (+) and goes to the point where you measure the voltage.

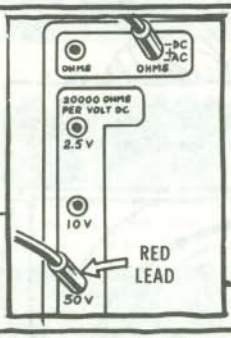


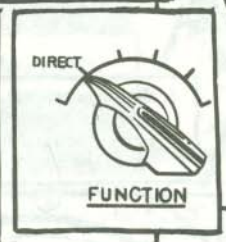
Bad connections, poor wiring and dirty switch contact points will cause errors in your voltage readings. To get accurate readings, measure at the exact circuit points given in the TM's electrical circuit troubleshooting diagrams. In short, avoid reading across connections and switches. (Unless you're testing for a high resistance point, or testing a complete circuit.)

MORE

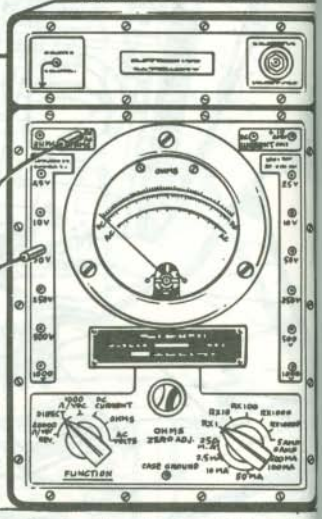
Use to find any voltage loss due to a bad part or faulty connection.

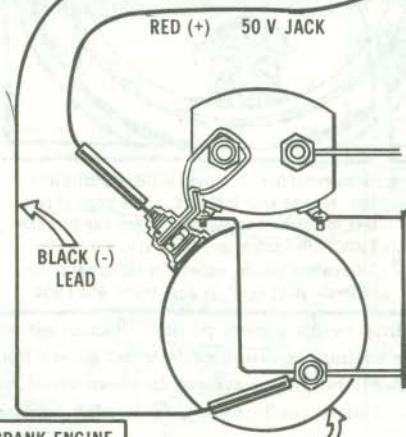
1. Leave the red (+) test lead in the 50v jack and the "FUNCTION" switch on DIRECT. Leave the black (-) lead plugged into OHMS-DC±AC jack.





2. Place your test leads across the suspected connection or part (red on the + side and black on the - side).



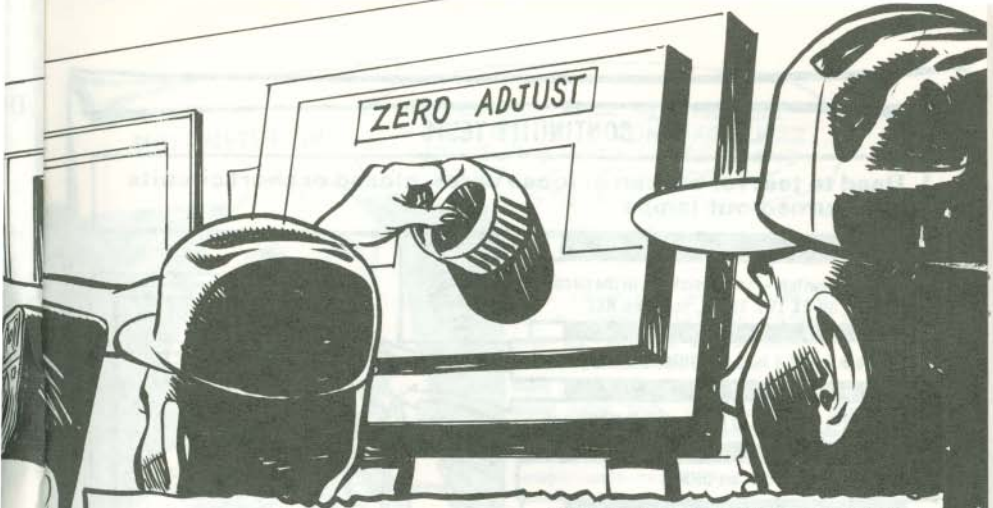


3. Now load down the circuit either by turn the headlights, the ignition switch, cranking the engine (first, disconnect t tributor's primary lead to keep the from starting. On diesels use the eme fuel cut-off.) What you do depends on t cuit being tested.

5. If you only got a flicker on the 50v scale, move the red lead to the 10v jack and try again. Still a flicker? Then move to the 2.5v jack. No voltage reading on the DC 25 (2.5) scale means connection or item is OK. But anything over 1 volt means trouble.

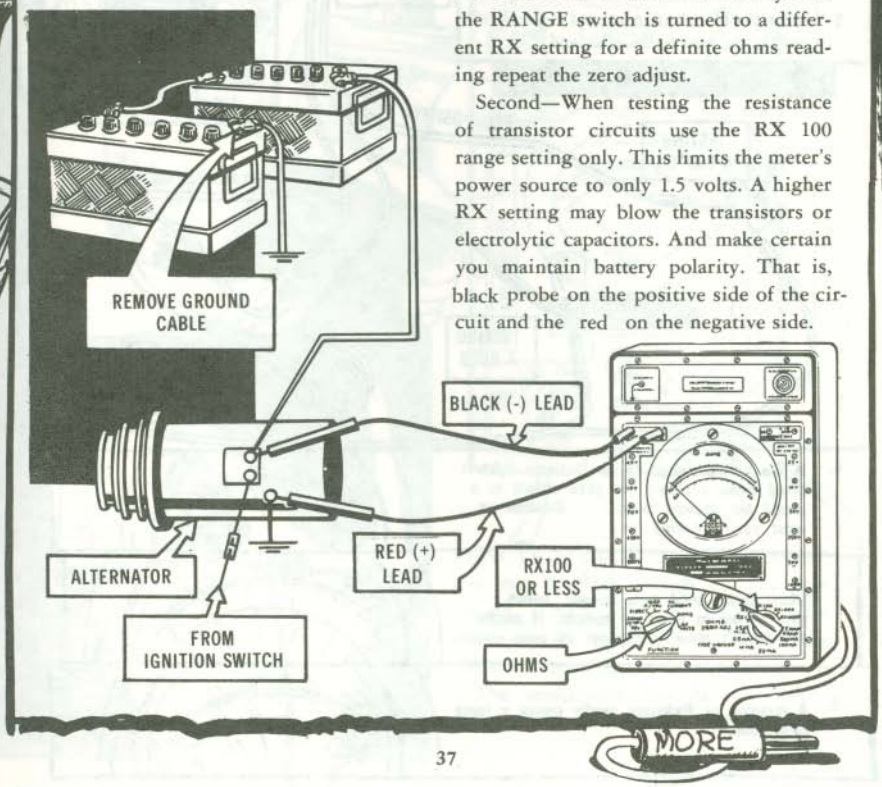
6. In all tests, stick to the equipment's -20 TM for specifics. Don't guess.

EVERYTIME YOU DUDES SWITCH RANGES, REPEAT YOUR ZERO ADJUST. DIG IT
7. Connect the probes across the item to be checked and read the ohms value on the meter's top scale. Don't forget to multiply the reading by the RX setting figure.
1½ TO 6 OHMS
PRIMARY TERMINAL
IGNITION COIL
RESISTANCE (OHMS) CHECK



Points to remember: First—Every time the RANGE switch is turned to a different RX setting for a definite ohms reading repeat the zero adjust.

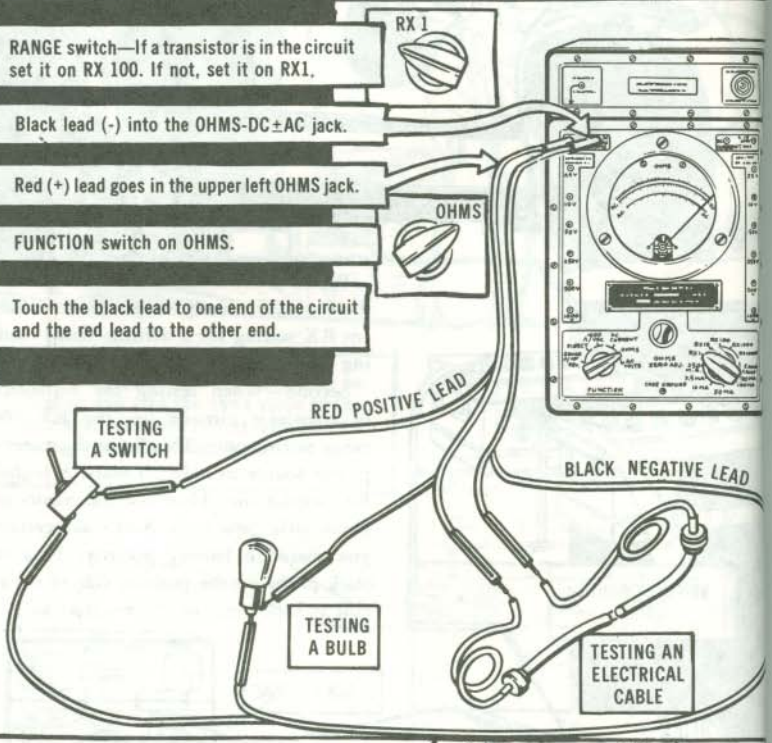
Second—When testing the resistance of transistor circuits use the RX 100 range setting only. This limits the meter's power source to only 1.5 volts. A higher RX setting may blow the transistors or electrolytic capacitors. And make certain you maintain battery polarity. That is, black probe on the positive side of the circuit and the red on the negative side.



CONTINUITY TESTS

Used to test for broken or loose wires, closed or short circuits and burned-out lamps

1. RANGE switch—If a transistor is in the circuit set it on RX 100. If not, set it on RX1.
2. Black lead (-) into the OHMS-DC±AC jack.
3. Red (+) lead goes in the upper left OHMS jack.
4. FUNCTION switch on OHMS.
5. Touch the black lead to one end of the circuit and the red lead to the other end.



6. If the needle swings to the extreme right it could mean a closed but good circuit or a closed but shorted circuit. . . Depends on what you're looking for.

7. When testing solid state circuits, switch your probes at point of contact. If needle still doesn't move you've got an open circuit.

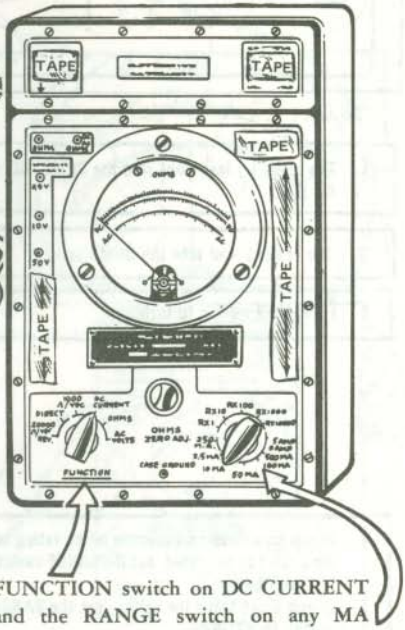
8. A jumping or flickering needle means a loose connection.

MULTIMETER TIPS

If you're only going to use the TS-352B /U on 28-volt automotive circuits, tape over the jacks as shown below.

TM 11-6625-366-15 (Jan 67) is the bible for the TS-352B/U. If you want to make other tests, check this TM first.

When putting the multimeter away, stow all the test leads in their proper compartment—neatly. And set the

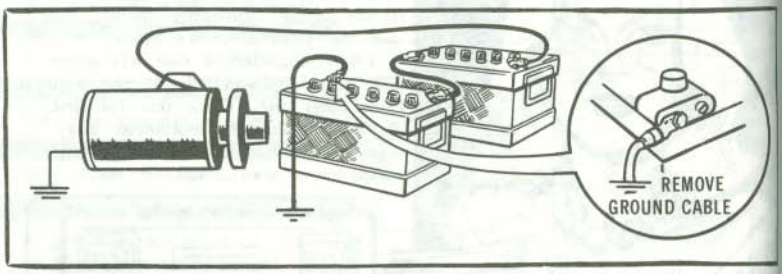


FUNCTION switch on DC CURRENT and the RANGE switch on any MA setting. This'll stop any battery drain and keep the meter needle from being jolted while being carried.

The multimeter has delicate mechanisms so be gentle. No rough handling, please!

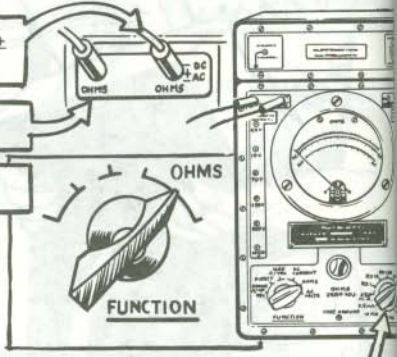
Used to measure resistance of coils and resistors

Before you start—make sure no battery voltage is connected to the circuit to be tested. Use the meter to see if any voltage is present. Or better yet—disconnect the battery ground cable. This'll stop a possible meter burnout.

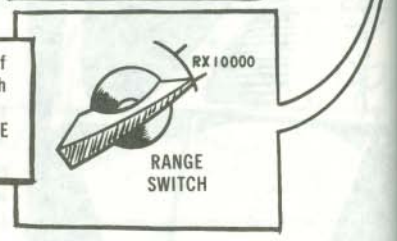


To test . . .

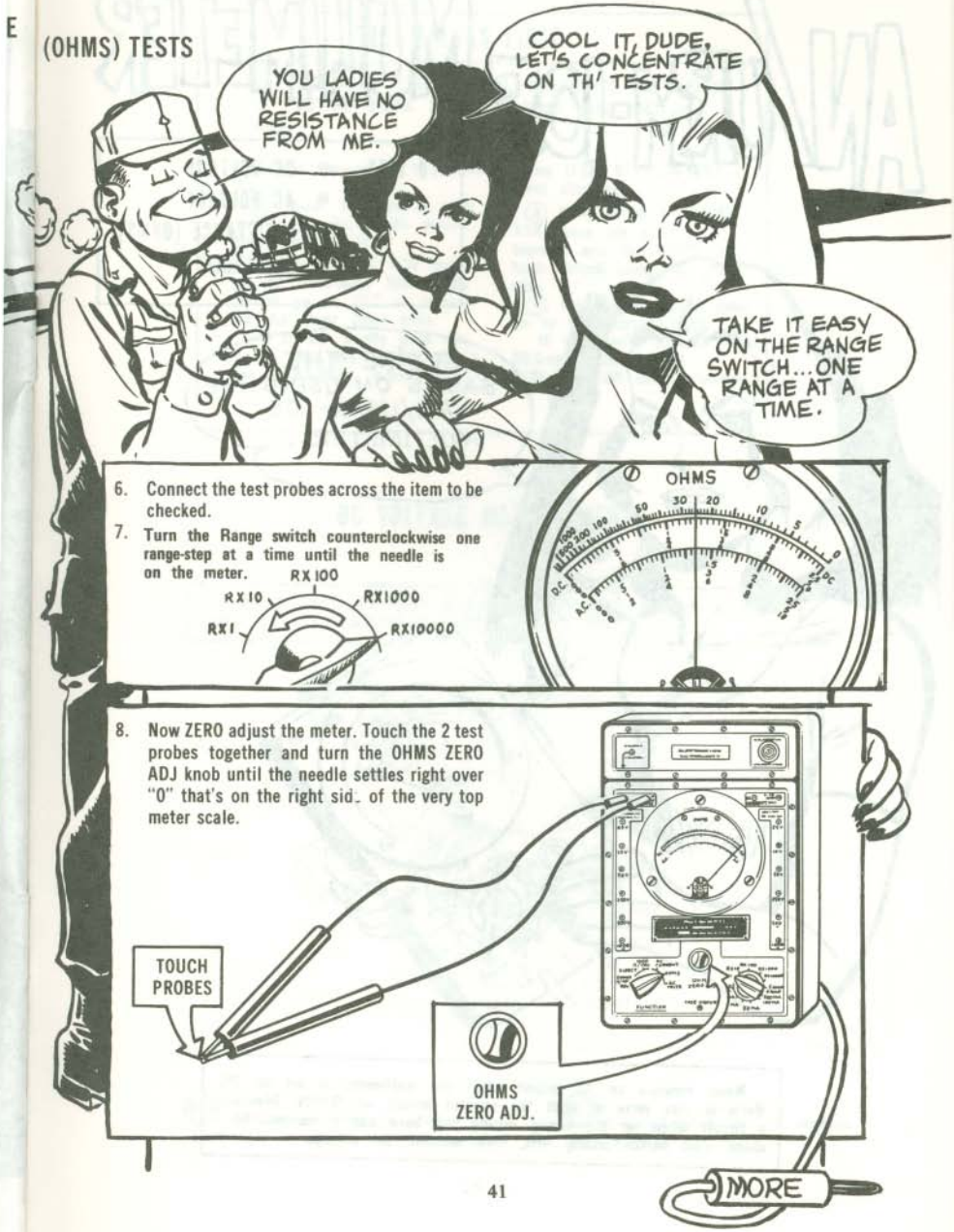
1. The black (-) lead goes into the OHMS -DC ± AC jack.
2. The red (+) lead into the OHMS jack.
3. FUNCTION switch to OHMS.



4. If you know the approximate ohms rating of the circuit to be tested, set the RANGE switch to that RX-value.
5. If you don't know the rating, set the RANGE switch to RX10000.



(OHMS) TESTS


YOU LADIES WILL HAVE NO RESISTANCE FROM ME.
COOL IT, DUDE, LET'S CONCENTRATE ON TH' TESTS.
TAKE IT EASY ON THE RANGE SWITCH... ONE RANGE AT A TIME.
6. Connect the test probes across the item to be checked.
7. Turn the Range switch counterclockwise one range-step at a time until the needle is on the meter.
RX100
RX10
RX1000
RX1
RX10000
OHMS
8. Now ZERO adjust the meter. Touch the 2 test probes together and turn the OHMS ZERO ADJ knob until the needle settles right over "0" that's on the right sid. of the very top meter scale.
TOUCH PROBES
OHMS ZERO ADJ.
MORE

USING THE AN/URM-105 MULTIMETER

TO TEST ··
- DC VOLTAGE
- AC VOLTAGE
- RESISTANCE (OHMS)
- CONTINUITY

Never measure an AC circuit when the multimeter is set on DC Volts—or vice versa or with the selector switch on OHMS. Measuring a circuit when on the wrong setting can burn out a resistor. So check your switch setting first, then measure the voltage.

FIRST THINGS FIRST . . .

BEFORE USING THE URM-105, CHECK ITS BATTERIES. IF THEY'RE WEAK YOUR READING WILL NOT BE TRUE.

① Set the switch to OHMS X1.

② Touch the tips of both test prods; the needle should swing to the right.

③ Turn OHMS ADJ completely clock-wise. The needle should go to "0" or beyond on the ohms (top) scale.

④ If the needle does not go all the way to the right, the 2 BA-58/U, 1.5-volt batteries (FSN 6135-120-1030) need changing.

⑤ Now switch to OHMS X1K; keep the prod tips together and the OHMS ADJ knob turned completely clock-wise.

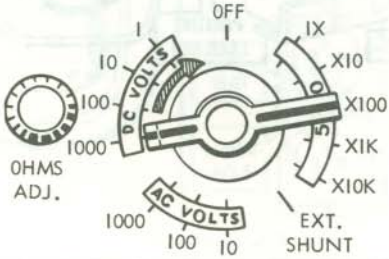
⑥ The needle should again go to the extreme right.

If it doesn't, the BA-261/U, 22.5-volt battery (FSN 6135-160-7159) needs changing.

DC VOLTAGE MEASUREMENTS

USED TO TEST BATTERY VOLTAGE, CHARGING SYSTEM OUTPUT AND VOLTAGE DROPS AT BAD CONNECTIONS.

1 Set selector switch in DC VOLTS 1000 position.



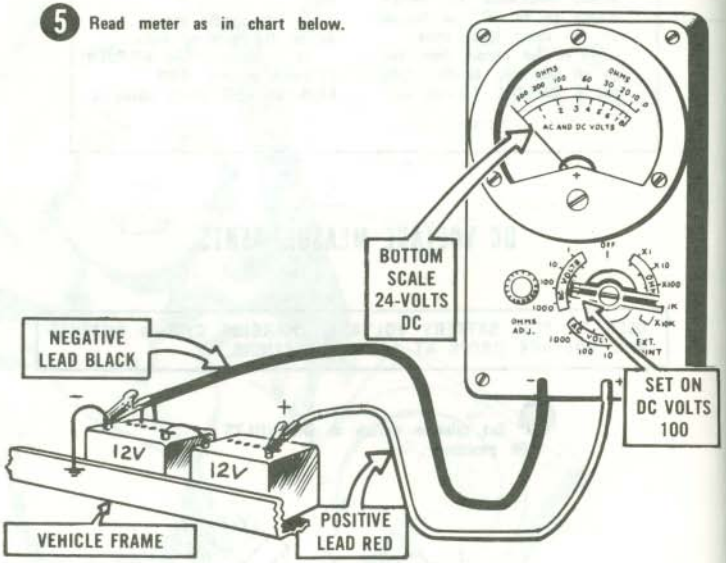
2 Connect red lead to positive (+) connection in circuit to be measured.

3 Connect black lead to negative (–) connection.

4 Move selector switch to 100, 10, or 1 setting to get reading near center of scale (dropping from high to low settings on switch protects meter. Overloads can ruin it).

CHECKING YOUR VEHICLE'S 24-VOLT BATTERY SYSTEM

5 Read meter as in chart below.



Switch setting	Range	You do
1	0 -1 volt	Divide the readings by 10.
10	0 -10 volts	Use direct meter reading.
100	0 -100 volts	Multiply meter reading by 10.
1000	0 -1000 volts	Multiply meter reading by 100.

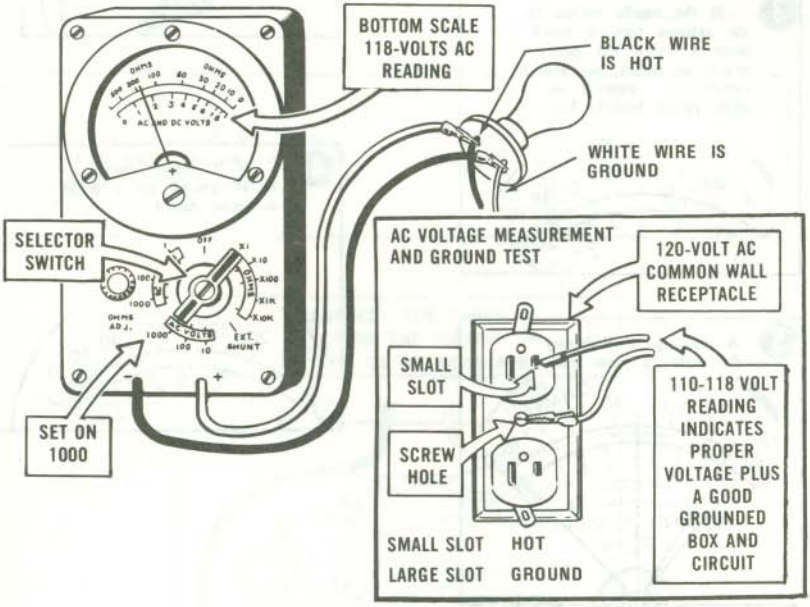
AC VOLTAGE MEASUREMENTS

USED TO TEST VARIOUS WALL RECEPTACLES FOR PROPER OUTPUT NEEDED TO OPERATE ELECTRIC TOOLS AND MOTORS.

(2) Connect leads to points to be checked (with AC voltage you can use black or red leads with no concern about polarity).

(3) Move selector switch to 100 or 10 position for center scale reading.

(4) Read meter as in chart below.



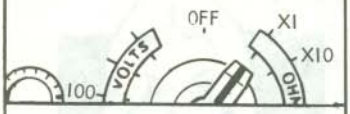
Switch Setting	Range	You Do
10	0-10 volts	Use red line reading
100	0-100V	Multiply reading by 10
1000	0-1000V	Multiply reading by 100

CONTINUITY TESTS

USED TO TEST FOR BROKEN OR LOOSE WIRES, CLOSED OR SHORTED CIRCUITS AND SWITCHES, PLUS TESTING FOR BURNED-OUT BULBS.

MAKE CERTAIN NO VOLTAGE IS CONNECTED TO CIRCUIT TO BE TESTED FOR CONTINU

1 Set selector switch to X1 ohms position.

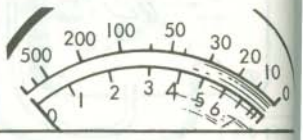


Zero meter: Touch prods together. Turn OHMS ADJ till needle is over "0" in top scale.

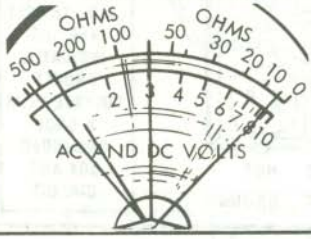
2 Now just touch the prods across the bulb, switch, cable or circuit that's acting up.

3 If the needle swings to the extreme right it could mean a closed but good circuit or closed but shorted circuit . . . depends on what you're looking for.

4 If it doesn't move at all you've got a break or open circuit.



5 A jumping or flickering needle means a loose connection.



ALWAYS MAINTAIN METER BATTERY POLARITY WHEN CHECKING CONTINUITY OF ALTERNATORS AND SOLID STATE CIRCUITS. YOU DO THIS BY USING THE RED AS NEGATIVE (–) AND BLACK PROD AS POSITIVE (+).

CAUTION

TO MAINTAIN METER BATTERY POLARITY WHEN WORKING ON ALTERNATORS AND SOLID STATE CIRCUITS USE THE RED PROD AS NEGATIVE(-) AND THE BLACK PROD AS POSITIVE (+).

WHY? BECAUSE THE RED LEAD IS CONNECTED TO THE (-) SIDE OF THE METER'S BATTERIES AND THE BLACK LEAD TO THE (+) SIDE.

RESISTANCE (OHMS) MEASUREMENTS

USED TO MEASURE THE OHMS RESISTANCE IN COILS, RESISTORS AND VARIOUS ELECTRICAL CIRCUITS.

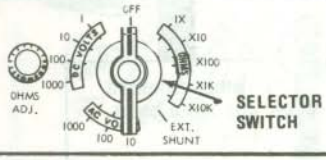
MAKE CERTAIN NO DC OR AC VOLTAGE IS CONNECTED TO THE CIRCUIT BEING MEASURED. MAKE A VOLTAGE TEST BEFORE SWITCHING METER TO AN OHMS SETTING.

- WHEN MEASURING RESISTANCE OF TRANSISTOR CIRCUITS USE THE X1, X10 AND X100 SETTINGS ONLY. THIS'LL LIMIT THE METER'S POWER SUPPLY TO 1.5 VOLTS. THE HIGHER SETTINGS PUT 22.5 VOLTS IN THE METER CIRCUIT AND THIS CAN BLOW TRANSISTORS OR ELECTROLYTIC CAPACITORS.

  AND YOU MUST MAINTAIN METER BATTERY POLARITY!

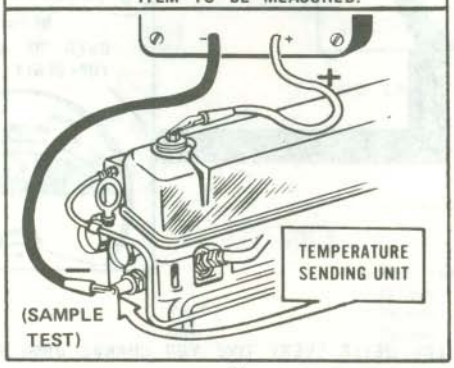
1

SET THE SELECTOR ON OHMS. IF YOU DON'T KNOW THE OHMS RATING OF THE CIRCUIT, SET THE SWITCH ON X10K.



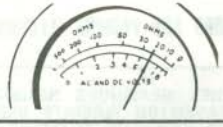
2

CONNECT THE PRODS ACROSS THE CIRCUIT OR ITEM TO BE MEASURED.



3

TURN THE SWITCH COUNTERCLOCKWISE UNTIL THE NEEDLE MOVES ONTO THE SCALE.



4

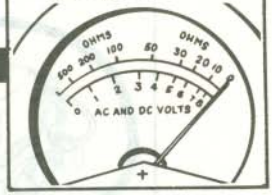
NOW ZERO THE METER. TOUCH THE 2 PRODS TOGETHER

5

. . . WHILE TURNING OHMS ADJ KNOB UNTIL. . .

6

. . . NEEDLE IS OVER "0" ON THE TOP SCALE.

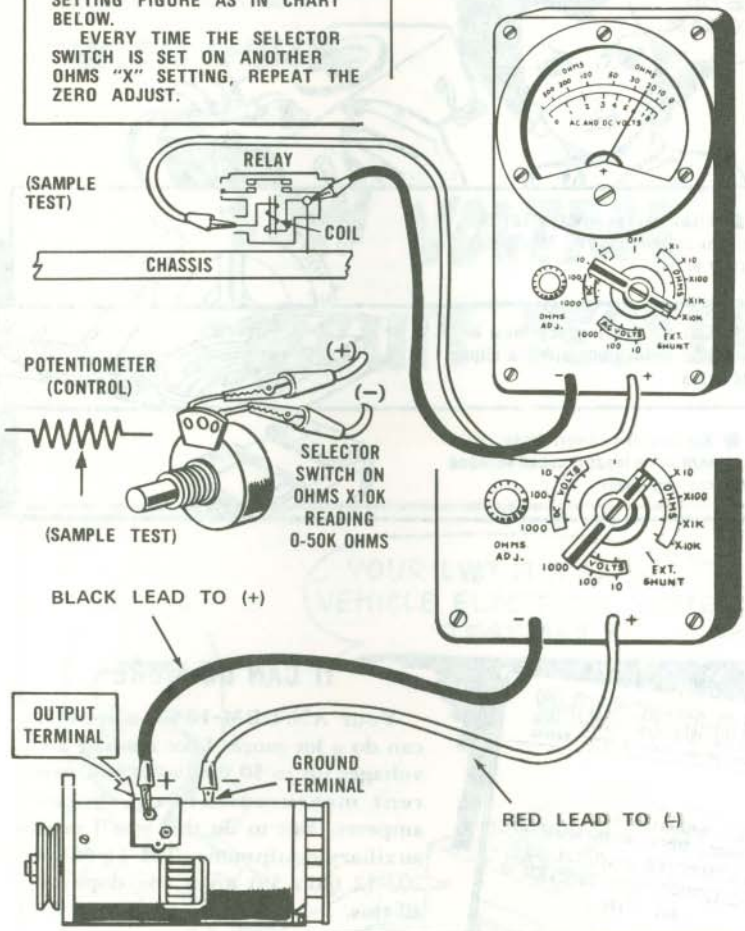


NOTE --- ZERO METER EVERY TIME YOU CHANGE OHMS SETTING.

7

CONNECT THE TEST PRODS ACROSS THE ITEM OR CIRCUIT TO BE MEASURED AND READ THE VALUE ON THE TOP SCALE. DON'T FORGET TO MULTIPLY THE READING BY THE "X" SETTING FIGURE AS IN CHART BELOW.

EVERY TIME THE SELECTOR SWITCH IS SET ON ANOTHER OHMS "X" SETTING, REPEAT THE ZERO ADJUST.



Ohms Switch Setting	You Do
X1	Read number on scale
X10	Multiply reading by 10
X100	Multiply reading by 100
X1K	Multiply reading by 1000
X10K	Multiply reading by 10000

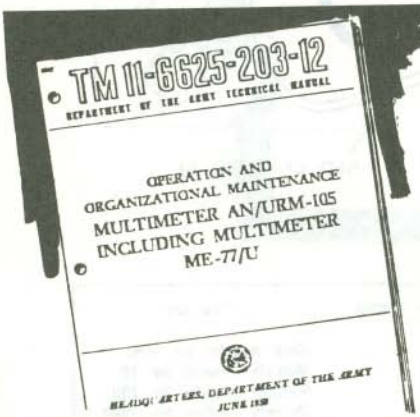
(Remember: K=1000)

MULTIMETER CARE:

- After using, always set the selector switch to "OFF". This'll stop battery drain.

- Coil the leads, place them on top of the panel along with the clips and prods.

- Replace the cover. Make certain there're no leads crushed between the case and cover.



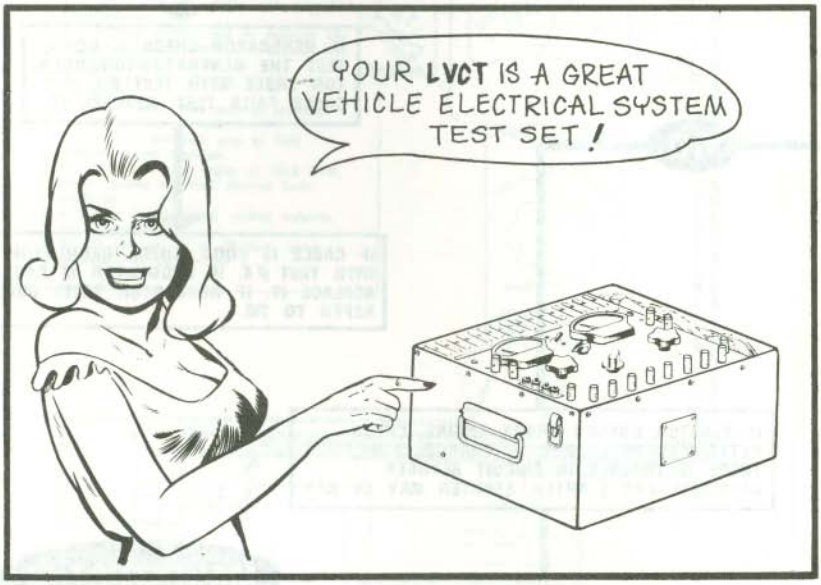
IT CAN DO MORE

Your AN/URM-105 multimeter can do a lot more. Like reading DC voltages up to 50,000 volts and current measurements up to 100 amperes. But to do this you'll need auxiliary equipment. TM 11-6625-203-12 (Jun 59) gives the dope on all this.

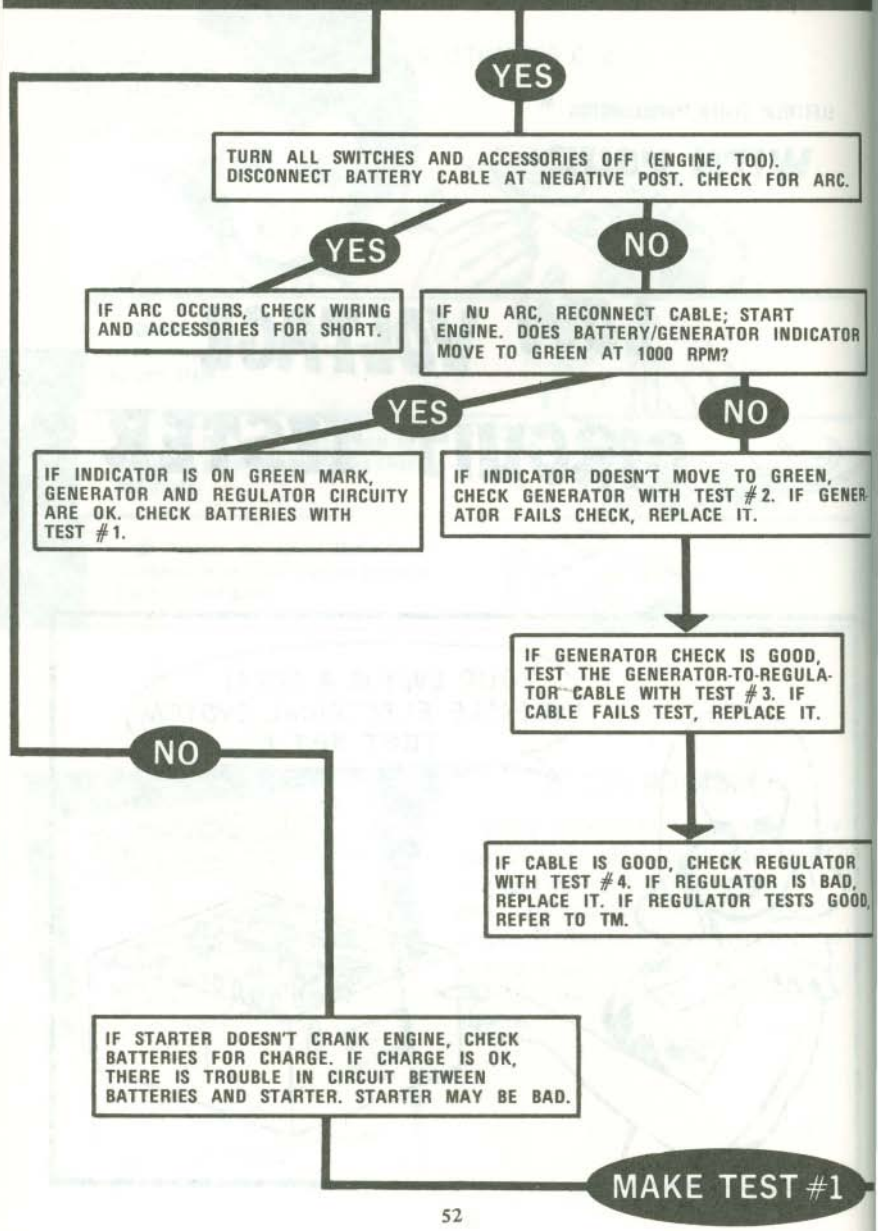
ELECTRICAL SYSTEM TROUBLESHOOTING *

WITH YOUR

LOW VOLTAGE CIRCUIT TESTER

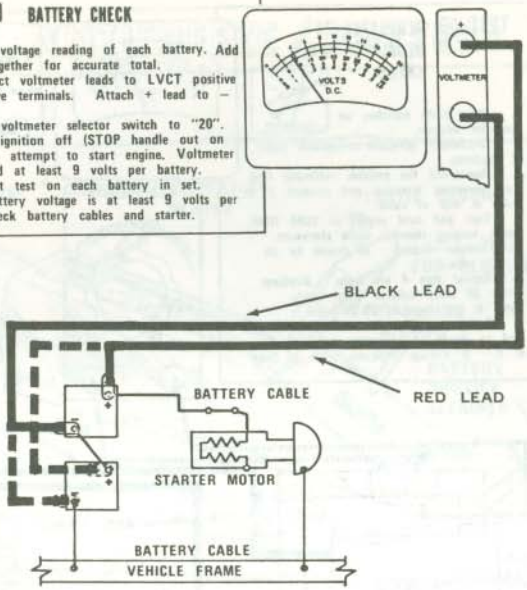


DOES STARTER CRANK THE ENGINE?



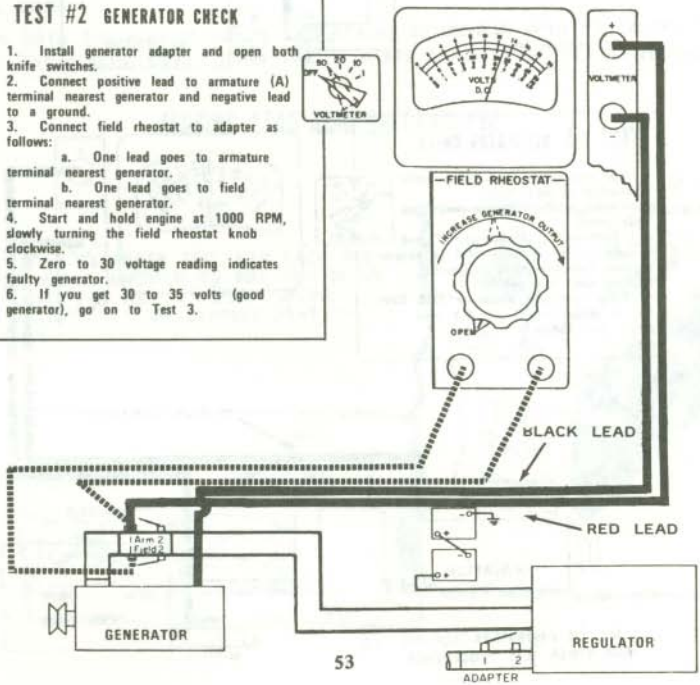
TEST #1 BATTERY CHECK

1. Take voltage reading of each battery. Add readings together for accurate total.
2. Connect voltmeter leads to LVCT positive and negative terminals. Attach + lead to – post.
3. Turn voltmeter selector switch to "20".
4. With ignition off (STOP handle out on multi-fuels), attempt to start engine. Voltmeter should read at least 9 volts per battery.
5. Repeat test on each battery in set.
6. If battery voltage is at least 9 volts per battery check battery cables and starter.



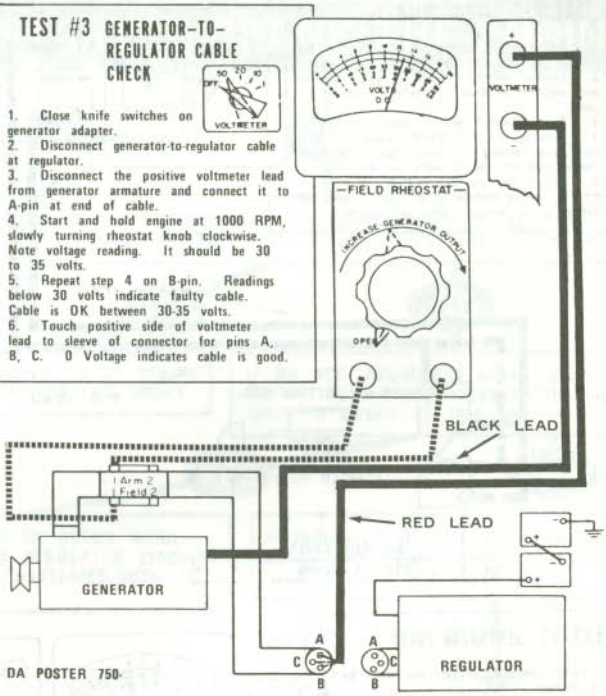
TEST #2 GENERATOR CHECK

1. Install generator adapter and open both knife switches.
2. Connect positive lead to armature (A) terminal nearest generator and negative lead to a ground.
3. Connect field rheostat to adapter as follows:
   a. One lead goes to armature terminal nearest generator.
   b. One lead goes to field terminal nearest generator.
4. Start and hold engine at 1000 RPM, slowly turning the field rheostat knob clockwise.
5. Zero to 30 voltage reading indicates faulty generator.
6. If you get 30 to 35 volts (good generator), go on to Test 3.



TEST #3 GENERATOR-TO-REGULATOR CABLE CHECK

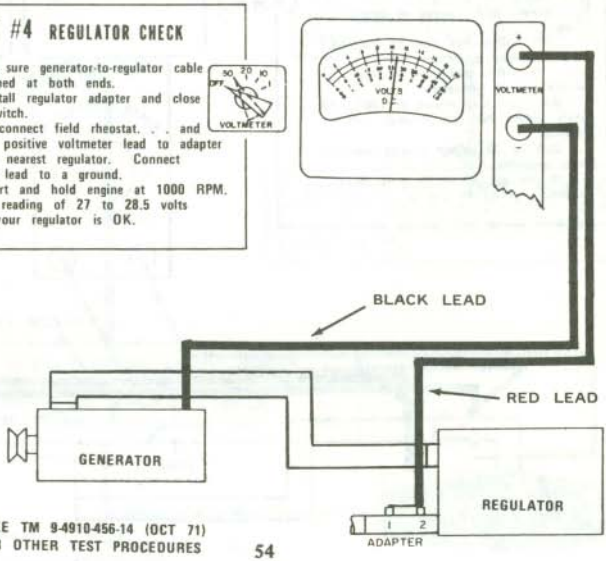
1. Close knife switches on generator adapter.
2. Disconnect generator-to-regulator cable at regulator.
3. Disconnect the positive voltmeter lead from generator armature and connect it to A-pin at end of cable.
4. Start and hold engine at 1000 RPM, slowly turning rheostat knob clockwise. Note voltage reading. It should be 30 to 35 volts.
5. Repeat step 4 on B-pin. Readings below 30 volts indicate faulty cable. Cable is OK between 30-35 volts.
6. Touch positive side of voltmeter lead to sleeve of connector for pins A, B, C. 0 Voltage indicates cable is good.



DA POSTER 750-

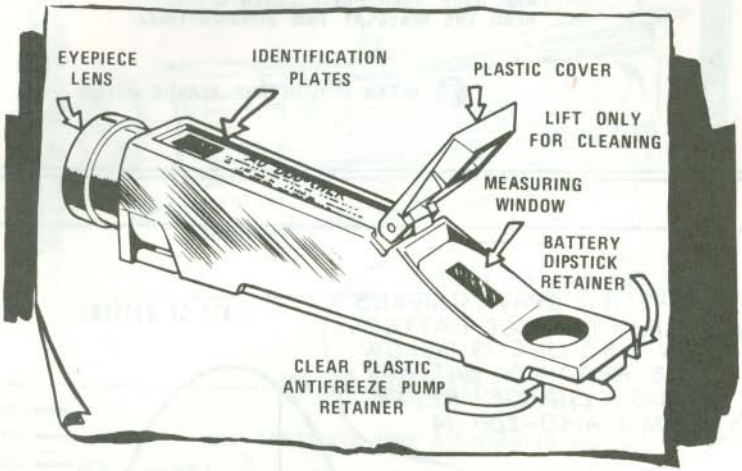
TEST #4 REGULATOR CHECK

1. Be sure generator-to-regulator cable is attached at both ends.
2. Install regulator adapter and close knife switch.
3. Disconnect field rheostat. . . and connect positive voltmeter lead to adapter terminal nearest regulator. Connect negative lead to a ground.
4. Start and hold engine at 1000 RPM.
5. A reading of 27 to 28.5 volts means your regulator is OK.



* SEE TM 9-4910-456-14 (OCT 71) FOR OTHER TEST PROCEDURES

OPTICAL ANTIFREEZE / BATTERY TESTER

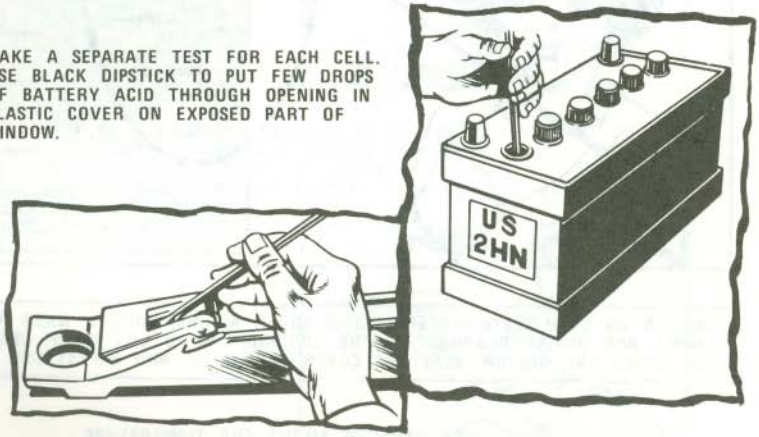


BEFORE USING . . .

1. CLEAN BOTH THE PLASTIC COVER AND MEASURING WINDOW WITH TAP WATER--THEN DRY.
2. SWING THE PLASTIC COVER DOWN TILL IT RESTS AGAINST THE MEASURING WINDOW.

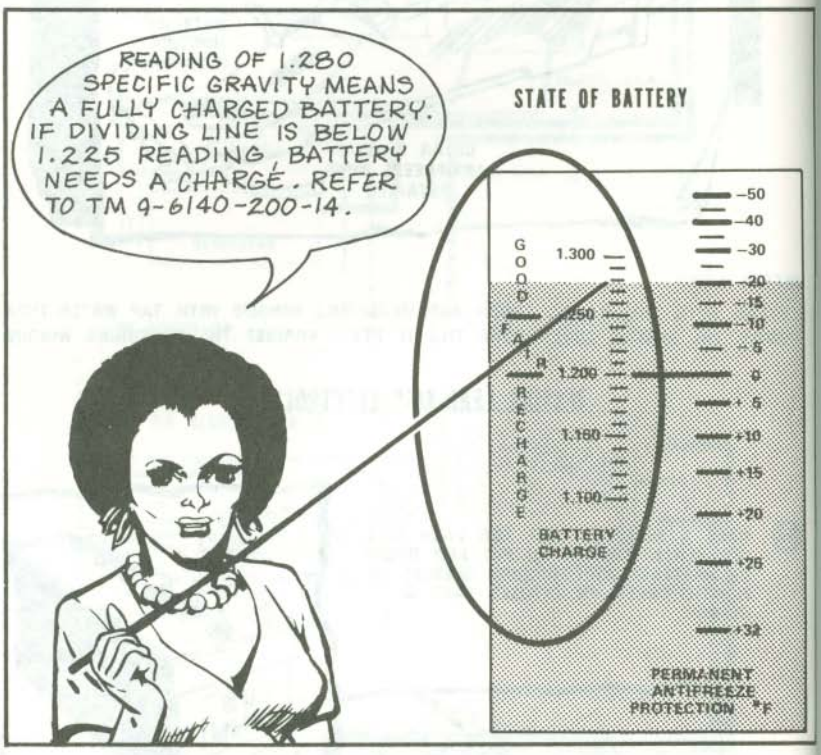
TESTING LEAD-ACID ELECTROLYTE

1 MAKE A SEPARATE TEST FOR EACH CELL. USE BLACK DIPSTICK TO PUT FEW DROPS OF BATTERY ACID THROUGH OPENING IN PLASTIC COVER ON EXPOSED PART OF WINDOW.



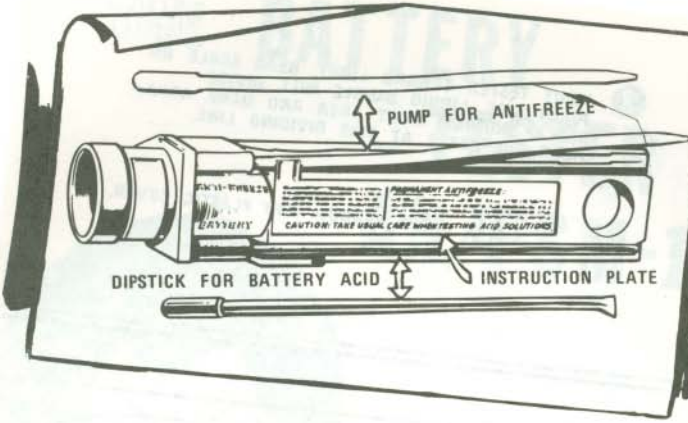
2 POINT THE TESTER TOWARD A BRIGHT LIGHT. LOOK THROUGH THE EYEPIECE AND READ THE SCALE ON THE LEFT SIDE. LIQUID SAMPLE WILL DIVIDE SCALE, SHOWING LIGHT AREA AND DARK AREA.* KEEP COVER CLOSED. READ THE SCALE AT THIS DIVIDING LINE.

3 CLEAN WINDOW AND PLASTIC COVER.



CAUTION ON BOTH TESTS: KEEP PLASTIC COVER AGAINST WINDOW WHEN INSERTING SAMPLE AND DURING READING. IF THE DIVIDING LINE IS NOT SHARP, CLEAN THE COVER AND WINDOW; SEAT THE COVER CAREFULLY, AND REPEAT THE TEST.

*YOU DON'T HAVE TO ADJUST FOR TEMPERATURE.



TESTING ANTIFREEZE

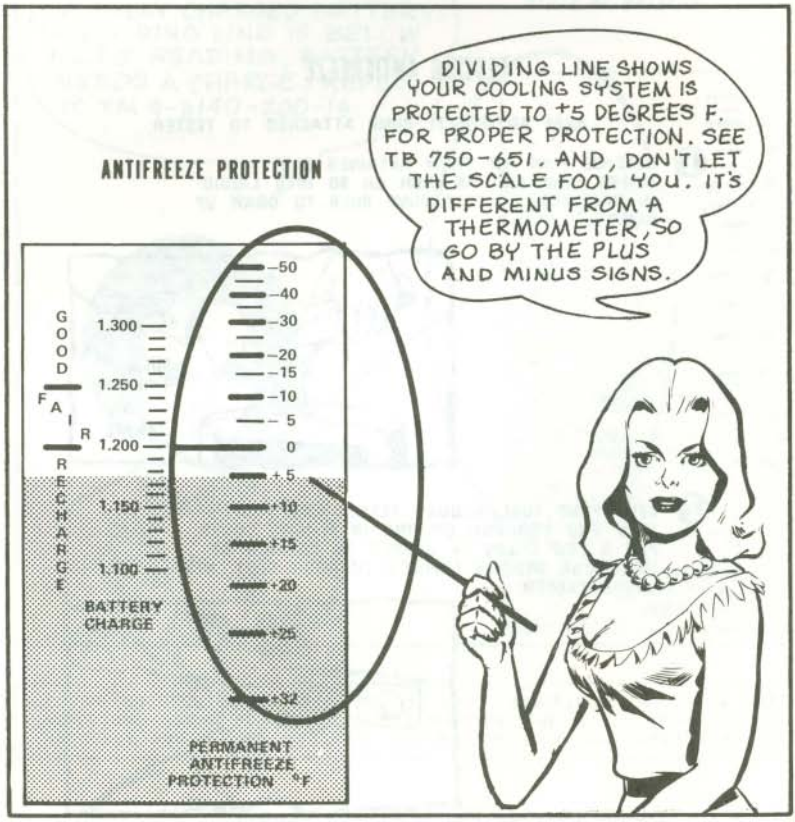
KEEP ANTIFREEZE PUMP ATTACHED TO TESTER.

1. RELEASE PUMP TIP FROM RETAINER CLIP. INSERT PUMP END AN INCH OR SO INTO LIQUID IN RADIATOR. SQUEEZE PUMP BULB TO DRAW UP SAMPLE.

2. BEND PUMP TUBE AROUND TESTER AND POINT PUMP END THROUGH OPENING IN PLASTIC COVER. PUT A FEW DROPS OF SAMPLE ON PORTION OF MEASURING WINDOW EXPOSED THROUGH SLOT. KEEP COVER CLOSED.

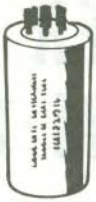
3 POINT TESTER TOWARD LIGHT, READ SCALE ON RIGHT SIDE. LIQUID SAMPLE WILL DIVIDE SCALE, SHOWING LIGHT AREA AND DARK AREA.* READ THE SCALE AT THIS DIVIDING LINE.

4 CLEAN WINDOW AND PLASTIC COVER.



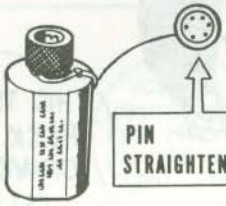
THE BATTERY TESTER AN/PSM-13

SIX ADAPTERS COME WITH EACH TESTER—EACH ONE FOR A SPECIFIC BATTERY.



U-240

U-297



PIN STRAIGHTENER

U-241

For all the details see TM 11-6625-823-15 w/C 1.

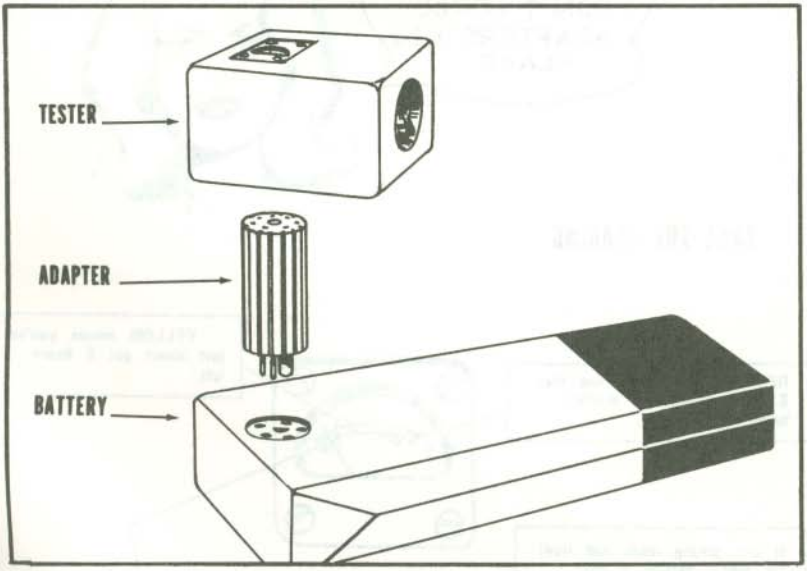
U-314

U-315

U-347

HERE'S HOW IT'S DONE. . .

1. Select correct adapter for your battery.
2. Connect adapter to tester.
3. Connect adapter/tester to battery.
4. Set tester switch for your battery, according to chart on next page.
5. Wait 15 seconds after setting switch. . .and read meter. Allow 15 seconds after each setting.



By Order of the Secretary of the Army:

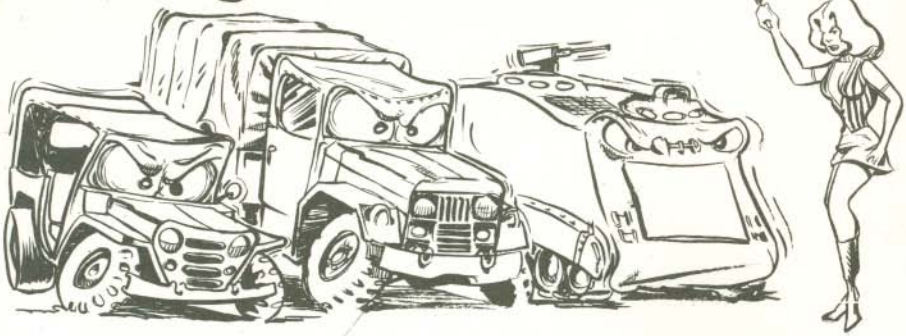
CREIGHTON W. ABRAMS
General, United States Army
Chief of Staff

Official:
VERNE L. BOWERS
Major General, United States Army
The Adjutant General

Distribution: Active Army, NG & USAR: TOE 6-365 (10); TOE 7-45 (10); TOE 17-35 (10).

U.S. GOVERNMENT PRINTING OFFICE : 1977 O—250-908

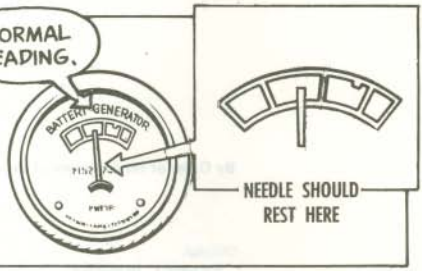
GO!...OR NO-GO



Your Battery-Generator Indicator lets you know!

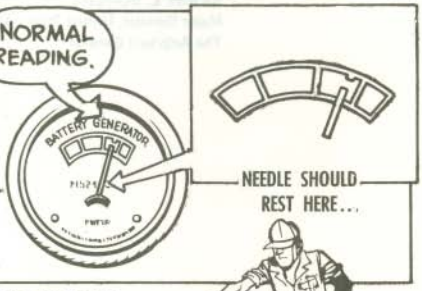
1st TEST

IGNITION ON. ENGINE OFF. ALL ELECTRICAL UNITS OFF...



2nd TEST

ENGINE RUNNING SMOOTHLY AT HIGH IDLE AND WARM; ALL ELECTRICAL UNITS ON.



NEEDLE IN **ANY** OTHER AREA MEANS **NO-GO** UNTIL A MECHANIC CHECKS OUT BATTERY AND CHARGING SYSTEM